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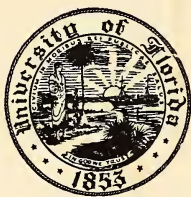
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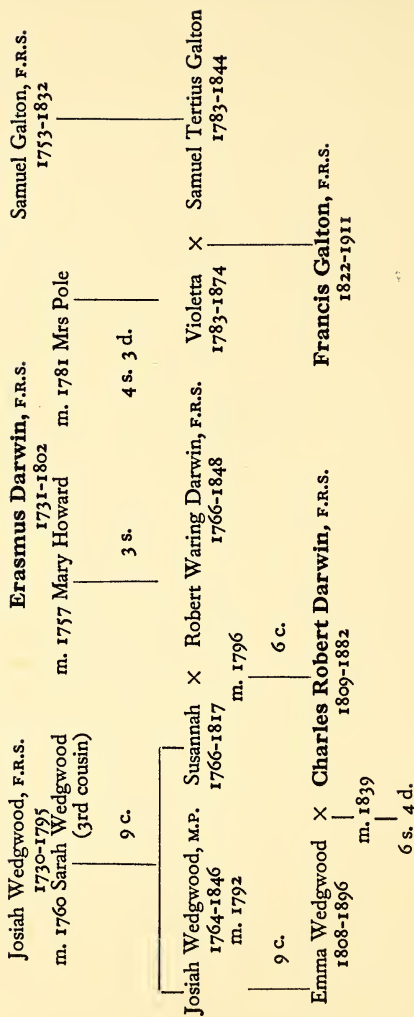
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DARWIN'S PLACE IN HISTORY

THE DARWIN CONNECTION



DARWIN'S PLACE IN HISTORY

C. D. DARLINGTON

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Rev. L. L. L.

PREFACE

THE present essay is an account of the issues that matter most in the work of Darwin, of their origins before his time and of their effects today. It is an account of a crisis in the history of science and indeed in the history of thought. It is of course a slight account fitted to the urgency of these problems rather than to their weight. The quotations, however, put together (for the first time) the basic documents of evolutionary theory. And the bibliography should enable those who wish to go further to follow the inquiry to its limits.

C. D. DARLINGTON

Botany School,
Oxford
February 1959

Rev. L. L. L.

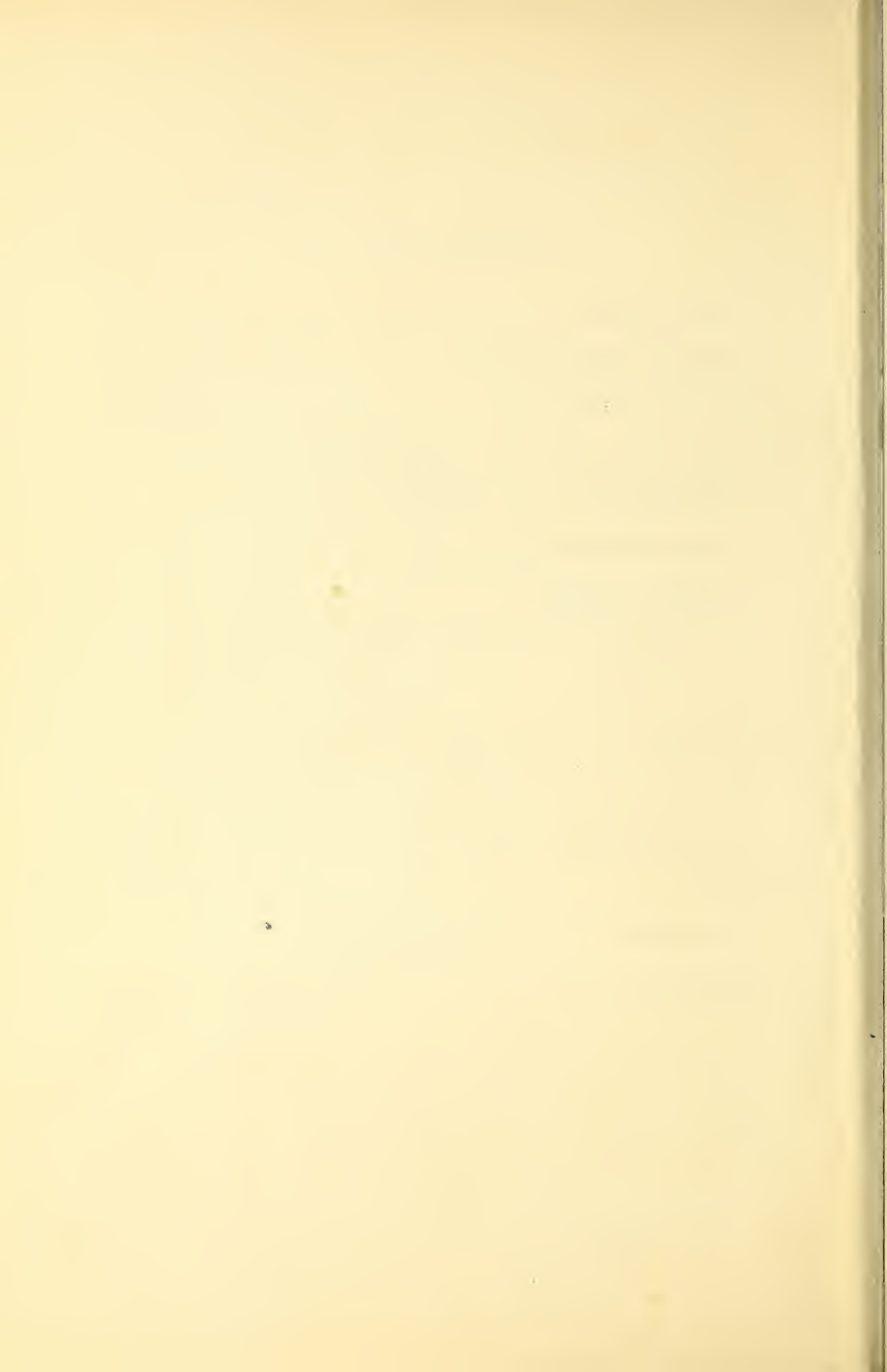
ACKNOWLEDGMENTS

I AM indebted to the Librarians of the Bodleian and Radcliffe Science Libraries and to Miss R. Guiney, Librarian of the Oxford Botany School, for invaluable help in the tracing of references. I am also particularly indebted to Mr Paul Harvey of the Manuscripts Department of the British Museum for the collation of the Lawrence Bibliography. For the translation of the Latin and French texts, which include certain technically debatable points, I am myself responsible.

C. D. D.

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PRINCIPAL CHARACTERS

Charles Darwin - 1809-1882

Leonardo da Vinci, 1452-1519

René Descartes, 1596-1650

Pierre-Louis Moreau de Maupertuis, 1698-1759

Georges-Louis Leclerc de Buffon, 1707-1788

James Burnett, Lord Monboddo, 1714-1799

Lazzaro Spallanzani, 1729-1799

Erasmus Darwin, 1731-1802

Jean Baptiste de Lamarck, 1744-1829

William Charles Wells, 1757-1817

Thomas Andrew Knight, 1759-1838

Thomas Robert Malthus, 1766-1834

William Lawrence, 1783-1867

James Cowles Prichard, 1786-1848

Patrick Mathew, c. 1790-c. 1865

Charles Lyell, 1797-1875

Robert Chambers, 1802-1871

Charles Robert Darwin, 1809-1882

Edward Blyth, 1810-1873

Charles Naudin, 1815-1899

Herbert Spencer, 1820-1903

Gregor Mendel, 1822-1884

Francis Galton, 1822-1911

Alfred Russel Wallace, 1823-1913

William Thomson, Lord Kelvin, 1824-1907

Thomas Henry Huxley, 1825-1895

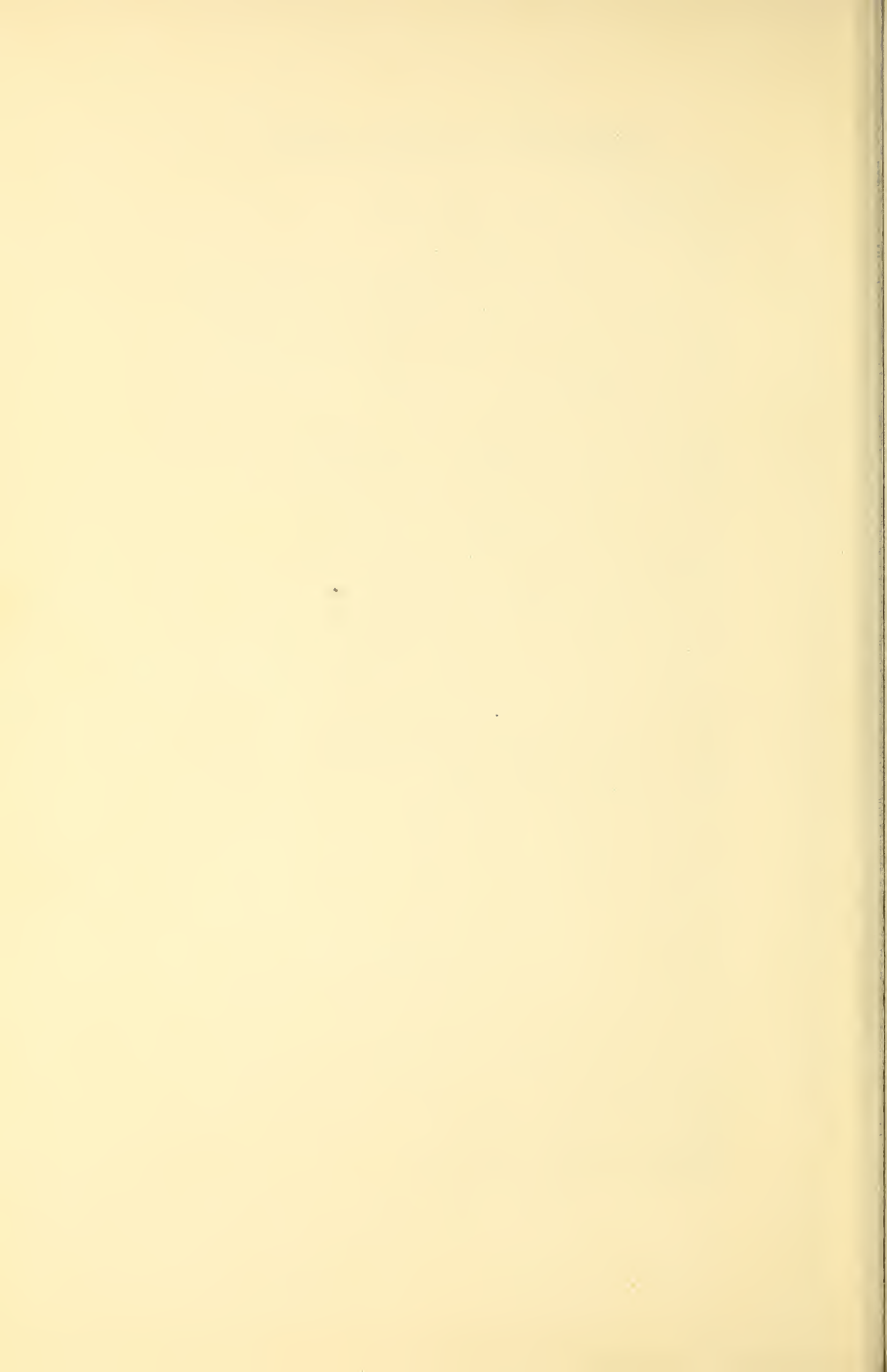
August Weismann, 1832-1914

Henry Charles Fleeming Jenkin, 1833-1885

Samuel Butler, 1835-1902

Hugo de Vries, 1848-1935

William Bateson, 1861-1926



1

THE PROBLEM

THE work of Charles Darwin, in his time, disturbed the course of human thought in almost every channel it follows. But human thought has a way, after the greatest disturbance, of moving back into its old channels. The *Origin of Species* which produced this disturbance appeared a hundred years ago. It is now worth while, therefore, asking ourselves a few searching questions. What was new in the ideas? Who was responsible for them? What effect did they have at the time? And what do they mean for us now?

These are the problems and their solution is hindered by several difficulties, some of them peculiar to the case of Darwin. First, there was the dispute, the bitter dispute which divided his contemporaries, between those who were for, and those who were against, evolution. Secondly, there were the conflicts in Darwin's own mind between extreme diffidence and a desire for recognition; between his deep interest in his own ideas and his desire for facts to support them — facts collected by other people who sometimes had ideas of their own. Thirdly, there was the habit among scientific discoverers of not quoting the more important antecedent authorities. All of us like to be supported by earlier observations, but few of us like to be anticipated by earlier ideas. Moreover, evolutionary theories were often held to be blasphemous or seditious and therefore to be concealed. Connections between ideas about evolution

which are of the greatest significance for this reason prove to be matters of conjecture.

Finally, there is now the difficulty of the change in scientific estimation of the work of Darwin himself in relation to those who preceded and followed him. The unknown work of Mendel, with the development of genetics which has sprung from it, has changed our view of Darwin's achievement. It has changed our view of his connections with what went before as well as with what has come after. As we shall see, it also raises a question, which Darwin recognized but was unable to broach, the question of what still lies ahead of us.

All these questions were, and some of them still are, loaded with emotion. We must try to answer them.

2

DARWIN'S SELF PORTRAIT

OUR first evidence of Darwin's work and character is, of course, his own books.

There is the *Voyage of the Beagle* in which the young naturalist describes with fresh vision his five years of adventure exploring the new lands and oceans of the southern hemisphere. There are then the three great works in which he attacks the problem of evolution, the *Origin of Species*, *Animals and Plants under Domestication*, and the *Descent of Man*. There are also the five volumes of his *Life and Letters* in which he discusses his ideas and their ideas with his perpetual advisers Lyell, Hooker and Huxley. And finally there is his *Autobiography* which, in the unexpurgated form now offered us, is perhaps the most illuminating document of all.

From these sources we get the impression of a man devoted to his scientific inquiries in which hypothesis and observation are beautifully balanced; but a man harassed by illness and restrained by his diffidence in coming to a conclusion. Twenty years had passed after he had read Malthus 'On Population' and seen in the 'struggle for existence' the solution to the problem of the transformation of species. Only then did he allow an essay to appear in a scientific journal. A similar essay had been sent to him for publication by the young professional collector, Alfred Russel Wallace, who was then stationed

at Ternate in the East Indies. Then he began to collect his notes and prepare his own work. At last he seemed to be in a hurry.

The *Origin of Species* owes its character to the fact that it was written in a hurry. It contains an argument based on his own wide observation and still wider reading, cut down—in its original edition—to the shortest length. The argument is that all kinds of living things when bred vary in character. When man breeds them he selects those he will use as parents. He selects them for his own purposes. Thus he produces new races or even new species. Pigeons are the chosen example. Nature over a vast period of time has been doing the same with all animals and plants. Her selection depends in part on the removal of the unfit. But in part it acts in new directions. Species spread from one region to another, from one habitat to another. And as they move they are adapted to new and diverse conditions.

The consequences of this doctrine of transformation of species, of transformation during descent from common ancestors, were to explain the similarities of structure and development of groups of plants and animals which could now be supposed to be of common descent. The existence of lines of fossil forms changing through the long succession of stratified rocks or of world history could be understood. The differences in character of species in the Old and New Worlds could be explained by gradual spreading from countries of origin to new countries. The diversity of birds or molluscs in small islands as contrasted with their similarity over large continents acquired a meaning. The existence of useless vestiges of organs, the development of instincts, the habit of cross-breeding, the sterility of hybrids, and dozens of other problems could be discussed; usefully discussed in a way that was not possible so

long as species were supposed to have been individually created by an inscrutable supernatural power.

The *Origin of Species* suffered from two quite different defects which we shall need to consider. Of one of these Darwin was aware; of the other he was not aware.

The first defect was that a theory of 'descent with modification' implied a theory of heredity and variation. Now according to Darwin's theory of heredity all differences between parents blended in their offspring. Yet this was clearly inconsistent with the occurrence of differences which we can all see, and which Darwin could see, between brothers and sisters. The assumption was incorrect and the whole theory in consequence imperilled.

The second defect was the absence of any account of where his ideas came from.

He begins the *Origin* with the words: 'When on board H.M.S. *Beagle*, as naturalist, I was much struck with certain facts in the distribution of the inhabitants of South America, and in the geological relations of the present to the past inhabitants of that continent.' And so the voyage of the *Beagle* appeared to be the beginning of everything. Darwin's theory, 'my theory' as he called it, appeared to the general reader to be something quite new. It had no connection with what certain scientists and philosophers had for thirty years described as the hypothesis of evolution. Darwin was indeed aware of the word Evolution but for many years he scrupulously avoided its use. And the only previous contribution to its study that he notes is the *Vestiges of Creation*, an anonymous work to which we shall return.

The consequence of Darwin's treatment was a widespread misconception. The name Darwinism which had earlier been applied to certain views of his grandfather became popular in

Germany as applied to the ideas of the *Origin of Species*. It was later used by Wallace as the title of a book. There have indeed for a long time been professors of Darwinism in Soviet Russia. But what exactly were Darwin's ideas, his own distinctive ideas, and what do we mean by Darwinism? This is not so easy to discover as we might expect. First, we must consider the men and the ideas that came before him.

3

THE GREAT PRECURSOR

THE nineteenth-century crisis in the struggle between creation and evolution was the climax of questionings that began much earlier, indeed, with the Renaissance itself. These questionings were for long unconnected with one another or with the similar unconnected questionings of ancient philosophers. Leonardo had argued against the inheritance of acquired characters. Others had argued for it. Montaigne had explored the mechanics of heredity in man. Descartes had timidly exclaimed upon the plausibility of gradual development as opposed to a sudden generation of life. For if individuals develop gradually, he had asked, why not life as a whole?

To put these different questions and answers together into one piece required that simple observations should first be fitted into one piece. The origin of life and the means of explaining its processes had to wait to be considered as a whole until the eighteenth century had revealed something more of the details of living things and of the scheme of nature behind them. When sperm and eggs and fertilization had been seen, when plants and animals had been bred experimentally, when development had been followed under the microscope, when the vast diversity of plants and animals had been named and classified and mapped on the face of the world, when the chimpanzee had been dissected and compared with men and

monkeys ... when all these things had been done, then belief and unbelief and different degrees of unbelief, could be measured and discussed.

Gradually unbelief, the rejection of the idea of creation, took the form of a theory of descent of all living things from common ancestors, descent with modification, with transformation. Here there were two questions. The first was the historical question: how do we know that it has happened? The second was the experimental question: can we repeat its processes and show how it could have happened?

These two kinds of question first came to be asked together and also answered together although obscurely and changeably in the writings of Buffon. A decisive pattern, a convincing argument, however, appeared for the first time only in the work of Darwin's grandfather at the end of the eighteenth century.

Erasmus Darwin was the leading physician of his day in England. At the height of his fame George III invited him to come from Lichfield to be his personal physician. Darwin, however, declined. We can now understand why. No less successfully than another and earlier physician, William Harvey, but in a very different way, he had used the practice of medicine as a means of understanding nature. He needed all the time at his disposal to put his ideas on paper. To this absorbing task he devoted his latter years.

In his numerous works, whether plain and open, in prose, or disguised in verse with indexed annotations, Erasmus Darwin lays down his belief that all living things are descended from a common ancestor. It was a belief based, no doubt, on the observations of Buffon. But it was aided, as he acknowledges, by the sceptical inquiries of Hume. What his predecessors had wrapped up he, therefore for the first time, ventures to

unwrap. He unwraps his conclusion and he also unwraps his evidence. How did he think it happened?

Erasmus's greatest work was *Zoonomia* or the *Laws of Organic Life*. Here he argues in a few pages that all organisms may be descended from a single ancestral filament. The process had taken 'millions of ages'. During this descent they had varied; they had been modified and transformed, just as domesticated animals and plants had been modified and transformed by man during his much shorter history.

These transformations in the evolution of the race were paralleled by the transformations in the evolution of the individual. For the plant or animal is not pre-formed in the egg but is transformed successively or 'epigenetically' in the course of development. The comparison of the processes of development in different organisms, therefore, reveals their relationships of descent. Other mammals may, in this way, be compared with man: some are closely related, others remotely related.

The accidents of evolution can be traced no less than its rules. Different geographical distributions of species reflect the places where they happen to have arisen. For example, the contrasts between the fauna of the Old and New Worlds are due to each new species having arisen in one and not in the other; or died out in one and not in the other. They have arisen, flourished and decayed at particular points in time and space.

Erasmus Darwin saw farthest in his last and posthumous work, the *Temple of Nature*. Here he seems to make use of the new work of Sprengel who had discovered the meaning of the cross-pollination of flowers, and of Spallanzani who had invented artificial insemination in animals. He represents the vegetative or 'solitary' or, as we should say, 'asexual' means of

reproduction as having given rise to more advanced methods; first, to hermaphroditism as in flowering plants; and later to a sexual differentiation between individuals as in the higher animals. He recognizes in this process the advantages of cross-fertilization which he has learnt from Sprengel. In doing so he foreshadows his grandson's three books on cross-breeding and flower structure. He also foreshadows the modern theory of the evolution of genetic systems, the evolution of heredity itself.

Erasmus also notices the degeneration of vegetatively propagated plants such as potatoes. Sometimes this is due to the development of an hereditary disease. Susceptibility to infectious disease is also, he points out, hereditary. And with regard to agents of disease he notes that the *variola* of smallpox reproduces and multiplies like an animal. Much of this is correct inference reaching into the twentieth century and we may doubt whether our present medical curriculum in its great breadth succeeds in reaching the same depth as Erasmus Darwin.

How had these transformations of descent come about? Erasmus did not give a name to the various possible assumptions. But he was the first to point them out and argue the evidence. These possibilities and these arguments underlie the chief theories of evolution that have followed his own. First, he proposed, as Buffon had done before him, that the environment altered heredity, that acquired characters were inherited, that heredity, as we may say, was *soft*. But the action, he suggested, was not always quite direct. The effects of use and disuse are inherited and here the environment is acting through the reaction or response of the organism. Secondly, he proposed that competitive and selective processes are an additional instrument of change. The grounds he discussed are

even more various than those later made so familiar by his grandson.

In the first place fertility, he points out (in the *Temple of Nature*), is hereditary and is subject to selection. Hence if one marries an heiress, an only child, one risks having no heir. This principle was repeated by many successors. It was rediscovered by his other grandson, the founder of eugenics, Francis Galton who claimed it as his own 'novel' hypothesis and 'adequate' to account for the decay of aristocracies.¹ Conversely over-population, which is the result of the over-abundant fertility of nearly all living things, leads to competition.² As for plants, 'many other changes seem to have arisen in them by their perpetual contest for light and air above ground, and for food and moisture beneath the soil'. In animals too there is not only ordinary competition but also competition among males for females: 'The final cause of this contest among males seems to be that the strongest and most active animal should propagate the species which should thence become improved.'

In this view we recognize the sexual aspect of natural selection. It is what Erasmus's grandson was to rediscover and propound under the name of 'sexual selection'. It had, of course, the Aristotelian twist, the 'final cause' from which no educated thinker had yet escaped. This twist is even clearer when he introduces another idea, that of the selective advantage of protective coloration or natural camouflage. This idea was to reappear in the work of Wallace. Indeed, these hypotheses and arguments of Erasmus Darwin were at the root of all later discussion whether of evolution or of the theory of populations.

¹ Galton (1869): an argument skilfully developed by Sir Ronald Fisher (1930).

² Zirkle (1941) has traced this idea back to Darwin's friend Benjamin Franklin (1755).

The spadework underlying Erasmus Darwin's botanical 'speculations' he described in his *Phytologia* which appeared in 1800, six years after his better known zoological work. Here he sets out the early experimental-plant breeding results of Thomas Andrew Knight which, for the first time, suggested the Mendelian principle of segregation. He also discusses the experience of an American plant breeder, Cooper of Philadelphia, a friend of Joseph Priestley. This man applied the inbreeding-cum-selection method, used by Bakewell in improving cattle, to the improvement of various crops, Indian corn, peas, squashes and radishes. When Erasmus spoke of inbreeding and selection he was not, therefore, idly speculating. He was inferring principles from his own observations and inquiries.

Erasmus Darwin's argument is characterized by the same endless curiosity and stubborn persistence that we meet again in his grandson. It was combined, to be sure, with a courage that was entirely his own. And courage, as we shall see, is one of the ingredients of success that must not be overlooked in this history.

It was no accident of heredity (let me add, in parenthesis) that remarkable gifts reappeared in Erasmus Darwin's grandchildren. For the character of Darwin's descendants no less than the character of his work depended on the companions he gathered around him. The 'Lunar Society' he assembled was intellectually the most effective provincial group that has ever come together in England. Its members and their friends, Joseph Priestley, Mathew Boulton, James Watt, Samuel Galton and Josiah Wedgwood were all fellows of the Royal Society of London. But it was in the Midlands that they established the Industrial Revolution and it was largely through the pen of Erasmus Darwin, when he moved to Derby, that they

illuminated the century which followed. The fact that their children and their grandchildren intermarried was another consequence of their friendships of continuing significance for our society.¹

Erasmus Darwin's works enjoyed immediate success equally at home and abroad. *Zoonomia* was translated into French, German, Russian and Italian and a pirated edition quickly appeared in New York. Also it was very properly put on the Roman Index. No doubt it prompted Malthus's *Essay on Population* which appeared four years later, and forty years later helped to give Charles Darwin as well as Wallace the idea of natural selection.² Samuel Butler supposes, however, that it was Darwin's *Loves of the Plants*, translated into French in 1800, which converted Lamarck to a belief in the transformation of species.

These were the works, perhaps in later editions — for they were frequently reprinted — which Charles Darwin read as a young man at the University of Edinburgh. It was from them that he learnt about the theory of evolution.

¹ Here we see a sequence of interactions between individual character, social preferences and mating group. These interactions accumulating in successive generations are the peculiarity of the genetic systems of civilized populations and determine their evolution. It is worth noting that the Lunar Society, one of its most elegant examples, should serve to connect three of the founders of evolutionary theory: Erasmus and Charles Darwin and Francis Galton (see pedigree: frontispiece).

² For the important expansion of the second edition of the *Essay* Dr A. H. T. Robb Smith tells me Malthus was indebted to the Prussian army chaplain Johann Süssmilch.

4

THE ISSUE: DIRECTION OR SELECTION?

LAMARCK's views, published in his *Philosophie Zoologique* in 1809, represent the next critical step in developing the ideas of evolution. It turns out to have been a step backward; but as often happens a step backward is a necessary step before a new advance. Lamarck selected certain of the causes of evolution propounded by Erasmus Darwin and named these as sufficient. There was nothing new in his ideas but he was the first person to sort the ideas out, and hence to produce an eclectic theory, a specific and explicit hypothesis to account for the transformation of species.

Lamarck assumed that variation was inherent in all reproduction; and it was inherently directed towards fitting the progeny to their environment better than their progenitors had been fitted to the same environment. The direction was given, as suggested by Erasmus Darwin, by the response of the organism. It followed either the inheritance of acquired characters or the inheritance of the effects of use and disuse.

This statement of Lamarck's set the stage for playing out the opposition between the two theories of variation, that is, of change in heredity, whose conflict had not been evident to his predecessors, the theories of direction and selection. For, on Lamarck's theory, heredity is soft and variation has a direction imposed on it *before* it arises, that is by the environment of

the parent. But on the selection theory, heredity is hard and variation has a direction imposed on it, if at all, only *after* it arises, that is by the environment of the offspring.

Again, on Lamarck's theory, no chance is involved in this direction. It follows inherently and it is inherently beneficial. It is in the nature of things that once life has arisen it shall elaborate, diversify and in some sense improve. On the selection theory the direction of change arises from the operation of innumerable chances whose results need not be beneficial. Thus in the background there is the opposition between design, purpose, and benevolent or divine guidance on the one hand, and on the other hand, blind chance without moral or meaning.

Now Lamarck's assumption is not only flattering (as he makes clear) to the Supreme Being. It is also flattering to our own self esteem. We like to believe in purpose and progress in heredity as in everything else. We have a goal and we want nature to have a similar goal. We hope for better things and we therefore believe in improvement. We cherish our habits and we hope our children will inherit them. The wish is father to every one of these thoughts and for this reason, no doubt, they have lain at the root of all popular beliefs about heredity from the beginning of human records.

Lamarck's achievement was simple enough. But it was not what it has been supposed to be. Before he had stated his assumptions they had always been believed. The softness of heredity, the inheritance of acquired characters, the process of direction, the three connected ideas whose long history has been thoroughly set out by Conway Zirkle, had always been taken for granted. They had been taken by most men as self-evident. No sooner had he stated what his assumptions implied, than the assumptions for the first time came to be doubted. They

took their place as working hypotheses capable of being questioned and even disproved. For they pretended to be natural history. They pretended to rest on observations.

What observations? Stags come to grow antlers in the mating season, says Lamarck, because their ancestors had always been so very angry at this season. The giraffe's neck, he adds, is so very long because its ancestors have had to stretch so very far for their food. Our brains grow so very large says Lamarck's disciple, Herbert Spencer, bringing the argument nearer home than Lamarck dared to bring it, because our ancestors have thought so hard. The effects of use and habit, experience and emotion are inherited.

Now these are not meaningless statements. They are assumptions about materials and events which we can test. Are the effects of our efforts and experiences inherited by our children? If we live in the tropics, do our children develop slightly darker skins than we ourselves? If we acquire some education, are they born slightly more educable than we were? Lamarck's pronouncement led people to examine these possibilities. And the results appeared in statements made separately and very quickly after the appearance of Lamarck's book.

The year 1809 was not the best time to advance a theory of evolution in France. Napoleon had come to terms with the Pope and the new idea made no appeal. But in England it was otherwise. Here the answer came.

The men who took up the challenge of Lamarck were three English physicians, Wells, Lawrence and Prichard. Being medical practitioners, their ideas were primarily concerned with man. The source of their ideas and the immediate cause of their publication is a matter of inference for, according to the custom which their predecessors had followed, none of them mentions Erasmus Darwin or Lamarck. The two younger

men merely dedicated their works to Blumenbach, the celebrated German founder of anthropology who had recently rediscovered the ancient classification of mankind by colour. Prichard also acknowledges his debt to Lawrence. But what they said makes clear what they had read.

These three men all denied soft heredity. They all denied the inheritance of acquired characters. They all turned to the alternative aspect of Erasmus Darwin's views to that elaborated by Lamarck, namely to the aspect of competition or selection. They were concerned with the two operations of contradicting the Lamarckian assumption and discovering a precise alternative. All three of them dropped the notions of purpose, design and final causes. To consider what these critical operations meant, we must go back to the beginning.

The conflict between planned direction and chance selection, between convergence towards ends and divergence from beginnings, had never been clearly stated by the two parties to it since classical times. But then it had been clear enough. On the one hand Empedocles asserted that by the operation of chance some creatures had been suitably formed and survived; other creatures had not been suitably formed and had perished. On the other hand Aristotle maintained that suitability or adaptation was just Nature and Nature was just design (*Physics*, II, viii).

Lucretius, as I have pointed out elsewhere, makes the same distinction. He favours determination and selection, against design and purpose. He favours random change selected after it occurs against directed change which does not need to be selected.¹

When these ideas revived in the eighteenth century the conflict did not revive with them; or not until Maupertuis who

¹ Appendix, p. 84.

seems to have studied Aristotle's views. Maupertuis's penetrating aphorism on the effects of artificial and natural selection is quoted by Bateson: 'Nature contains the stock of all these variations: chance or skill brings them into being.' Moreover Maupertuis doubted the inheritance of the effects of mutilation: he thought it should be tested by experiment. With Erasmus Darwin directed and selected changes were balanced. It was this balance that was broken by Lamarck and by those who contradicted him.

Thus Prichard writes in 1813: 'All acquired conditions of the body end with the life of the individual in whom they are produced ... But for this salutary law ... the universe would be filled with ... monstrous shapes.' Similarly, Lawrence in 1819 marshals the evidence from variation in man to show that neither climate nor food nor civilization nor government had any influence on the differentiation of races. And again Prichard (in his second edition cited by Poulton), having asked how varieties are developed in particular climates or situations, answers: 'One cause ... is obvious. Individuals and families and even whole colonies, perish and disappear in climates for which they are by peculiarity of constitution, not adapted.'

Later, in his third edition, Prichard loses his nerve. He begins to admit the possibility of a direct action of the environment (guided by our Maker) and as he does so natural selection fades from his picture. In taking this course, in retreating from the theory of selection, Prichard professes the same sequence of beliefs which Charles Darwin was to follow in his turn. Why did he retreat? The reason we learn from what happened to Lawrence. Indeed the unknown story of Lawrence explains to us more than anything else the private submerged conflict which lies under the public and visible history of Darwin.

5

THE SUPPRESSION OF LAWRENCE

LAWRENCE published his book on the *Natural History of Man* in 1819. In it he drew up an account of the physical and mental variation of the races of man. Informed by this account but inspired, we can hardly doubt, by Erasmus Darwin and encouraged by Prichard, he reached the following remarkable conclusions:

1. Physical, mental and moral differences in man are hereditary. Further, different individuals and races are by heredity susceptible to different diseases.

2. Races of man have arisen by mutations such as are seen to distinguish different kittens or rabbits in a litter. He refers to the very observation in Lucretius which I have quoted as illustrating Mendelian segregation.¹

3. Sexual selection has improved the beauty of advanced races and governing classes.

4. Characters of races and nations are preserved by the breeding barriers between them, by what we in the twentieth century call 'genetic isolation'. Breed or 'Gattung' is the basis of all classification.

5. 'Selections and exclusions' are the means of change and adaptation. Differences, mental and physical, between races of

¹ Appendix, p. 84.

men can never be related to differences in external conditions such as food, climate or government.

6. Men can therefore be improved by selection in breeding just as domesticated animals are improved. Conversely they can be ruined by inbreeding in the absence of selection, a consequence to be observed in many royal families and aristocracies.

7. Zoological study, the treatment of man as an animal, as an object of natural history, is the only proper foundation for teaching and research in medicine, in morals or even in politics.

Most of these arguments had been set out before. No intelligent man in the age of Bakewell's stock-breeding, and in an age when dogs were usually bred to be taught and trained doubted that intelligence in man is inherited. On this point, although on no other, Dr Darwin and Dr Johnson had been prepared to agree. And it shocked no one except his victim for Dr Johnson to say: 'I would advise no man to marry, Sir, who is not likely to propagate understanding.' But here in Lawrence's work every fact was laid down and every conclusion was drawn without any respect for persons or proprieties. The continuance of orderly government as established under the Prince Regent, the landed aristocracy and the Church of England was being obviously and openly attacked.

Lawrence was a professor at the Royal College of Surgeons in London, aged 30, when he began the series of lectures (1813-16) on which this book was based. Its effects were diverse. Radical writers were delighted with the flavour of 1789. That irreverent novelist Thomas Love Peacock was prompted to exercise his fancy on an Orang who bought a baronetcy. But serious people were shocked. The Church and, in consequence, the universities which the Church controlled, were outraged.

The political situation at the time was of course extremely dangerous. The official reaction was inevitable. Lawrence was repudiated by the leading member of his profession, his own teacher, Abernethy. There are seven books in the British Museum, five anonymous, four by the clergy, confuting or denouncing him, often with a wealth of biological argument. Lord Chancellor Eldon declined to allow copyright on the grounds that the work contradicted the Scriptures.

In these circumstances Lawrence had a fearful choice before him. Prosecution, or at least persecution and professional ruin, faced him if he continued to sponsor the book. With the example of Joseph Priestley before him (of which he had no doubt been reminded) he suppressed his own book. Keeping to his own job, earning his own living and publishing only technical works, he survived the crisis. He became in due course President of the Royal College of Surgeons and Sergeant-Surgeon to Queen Victoria. Before he died in 1867 she made him a baronet. Never again had he ventured to express his views in public on the processes of evolution, on the past or the future of man.

As a footnote to this story I like to recall that Lawrence noted that the pronunciation of the Hottentots 'which is like the clucking of a turkey' is connected with the shapes of their mouths. 'The boney palate is smaller, shorter and less arched than in other races.' Here he anticipated my own theory of the phonetic evolution of language, a theory which would seem to be self-evident, but one which Darwin and the Darwinians (and of course the linguists) failed to rediscover.

After the suppression of Lawrence's book, nine illicit but apparently quite unexpurgated editions were produced. Of these, five versions and two extracts are in the British Museum. In addition there is a letter from Lawrence to a courageous

bookseller, William Hone, who was evidently going to produce the first unauthorized edition.¹ For thirty years the book remained a centre of controversy, applauded by Chartists and radicals, denounced by the most respectable authorities.

Forty-four years later, as he relates in his preface to *Man's Place in Nature*, the young T. H. Huxley was warned by Lawrence not to broach this dangerous topic of the evolution of man. Lawrence, he said, 'one of the ablest men whom I have known had been well-nigh ostracized for his book *On Man* which now might be read in a Sunday-School without surprising anybody'. I judge from this remark and from his chapter in Darwin's *Life and Letters*, that Huxley had not read Lawrence's book, or not since his own conversion in 1859. Nor had Darwin. For neither of them supports or contradicts Lawrence on the theoretical issues that he examines. If either of them had done so he would have been able to write a better book.

Francis Darwin suggests (in 1903) that his father unluckily saw only a late edition of Prichard which was not clear on the evolution or transformation issue. But there was only one text of Lawrence. That text puts the issue in its contents pages. Darwin quoted the book five times on points of detail but never on the main issue.

Before we pass on we may note the reasons for Lawrence's failure or rather disaster. He made three mistakes. He acknowledged his indebtedness to predecessors. He based his views on man. And he pointed out all the implications for the society of his day.

An indirect connection between the ideas of Lawrence and of Darwin is to be found in Patrick Mathew. It was Mathew who indignantly claimed the theory of natural selection as his

¹ Bibliography, p. 101.

own, and had his original statement of it from 1831 reprinted in the *Gardener's Chronicle* in 1860. This statement was made in an appendix to a work on the growth of timber for warships. Mathew, in a few brilliant pages irrelevant to his main theme, had expounded a complete theory of evolution.¹ In the same book he had also introduced a few equally irrelevant but equally illuminating views on the evolution of race and class in man and the decay of aristocracies. These opinions as a whole are related to only one source, to the conclusions which Lawrence had recently derived by close reasoning from the evidence.

Evidently Mathew had read Lawrence. Evidently also in his statement of natural selection as a principle governing the origin of species he makes an advance on Lawrence. What is more remarkable is that he expresses himself more rigorously than Darwin was able to express himself in the *Origin of Species* twenty-eight years later. For he attributes evolution to natural selection without reservation. And, like Maupertuis, he adds that, as for Lamarckian adaptation, we may test the possibility of it by experiment. This suggestion again fell by the wayside until after Darwin's death. Mathew was certainly justified in claiming the theory but he in his turn failed to acknowledge his precursor, William Lawrence.

The issue is thus clear. As the cause of adaptation and evolutionary change Lamarck believed only in direction before variation; the English medical evolutionists believed only in selection after variation. The issue and the conflict between these two opposed explanations of evolutionary change was the great advance on the misunderstanding of earlier generations. It avoided the treatment of the two possible modes of evolutionary change by direction and by selection as parallel

¹ Appendix, p. 90.

and supplementary. It showed them as antithetic as Aristotle believed them to be, and as we believe them to be. But the full development of the antithesis was, as we shall see, delayed by the work of Darwin, delayed until after his death.

6

ON THE THRESHOLD

WE can now return to consider the making of the *Origin of Species*. Two problems are entwined in the story of the twenty years' work of preparation. The one concerns Darwin's personal conflict. The other concerns the social conflict, the conflict between belief and inquiry which was moving towards a crisis at this time.

After his return from the voyage of the *Beagle* in 1836, Darwin married his cousin Emma Wedgwood and soon settled at Down. Provided with a sufficient income which he increased by wise investment, he was able to devote the rest of his life to study and writing. For the first eighteen years he was occupied, or at least preoccupied, with completing the account of research begun on the voyage. Ten years were spent on his *Geological Observations*, the *Journal of Researches* and the evolutionary account of *Coral Reefs*. Another eight were consumed in the less profitable work of classifying and describing the barnacles collected on the voyage. He had, however, paused to jot down many notes on the theory of transformation. He had drawn up a sketch of the theory of natural selection in 1842 and enlarged it to 50,000 words, a reasonable size for a book, in 1844. But only in 1854 did he set to work in earnest to write a book for publication on the subject, the book which was interrupted four years later by his hearing that Wallace had independently reached the same conclusion as himself.

Here we must notice a significant point. Darwin and Wallace announced their opinions together to the Linnean Society on July 1st, 1858, and their papers were published together two months later. Everyone agreed, friends and enemies, that this was one theory: the Darwin and Wallace theories were the same. But in fact their arguments and their conclusions differed in a respect which is crucial for our understanding of Darwin.

Wallace, on the one hand, refers to Lamarck and repudiates the Lamarckian theory. The giraffe did not grow its long neck directly through 'desiring to reach the foliage of the loftier shrubs and constantly stretching its neck for the purpose'. Its neck is long because those of its ancestors who had longer necks could reach more leaves on taller trees and so survive longer. Selection is shown as opposed to direction, as an alternative to direction. By all our present understanding of science this is the correct approach. And it is also the correct conclusion. The approach and the conclusion Wallace still maintained thirty years later when he wrote his book entitled *Darwinism*.

Darwin, on the other hand, does not refer to his predecessors. He does not refer to Lamarck's principle even to repudiate it. He advances the theory of natural selection. But he does not deny alternative possibilities of directed change or of the inheritance of acquired characters. Selection, he writes, acts on variations which may perhaps be caused by external conditions. He leaves open a line of retreat from *caused* to *directed*, the line he was later with unnoticed steps to follow.

During the whole twenty years, indeed, Darwin while he was obviously anxious to have the credit for his idea one day, was alarmed at the prospect of advancing it or defending it. And he was still more alarmed at the prospect of attacking the citadel of nineteenth-century belief. Church and universities,

scientists and educated laymen seemed agreed in treating the idea of transformation with hatred as well as contempt. Such, at least, was his impression. There was therefore no danger of anticipation, no hurry — until the letter came from Wallace. Darwin's impression, however, had been false. It had been due to the sheltered and settled life he led and the very respectable academic correspondence which he maintained.

Darwin's unawareness of what his contemporaries were thinking matched his unawareness of what his predecessors had written. He saw the evidence of evolution accumulating: so much of it the work of the geologist Charles Lyell and the botanist Joseph Hooker, his regular correspondents. He collected and edited it as material for his own arguments. He did not realize that others were doing the same kind of thing. This unawareness Bateson attributes to his isolation, meaning his geographical isolation at Down. But it was rather a genetic isolation due to his extreme (and we may say fruitful) self-centredness. We can see this from his correspondence with Wallace.

In 1855, Wallace had written a closely reasoned article attempting to throw light on the 'introduction of new species'. He had combined all the available evidence of geological succession and geographical distribution to show that life had undergone a continuous process of change through the earth's recorded history. He is surprised that no notice has been taken of it. Darwin replies that 'very few naturalists care for anything beyond the mere description of species'. He adds warily: 'I believe I go much further than you; but it is too long a subject to enter on my speculative notions.'

Thus Darwin did not allow his theoretical interest to overcome his desire to keep his priority in what he believed to be his own great idea. Nor did he allow it to prevent him

assembling his forces with a prudent strategy without which he would never have won his battle. For, he adds: 'you ask whether I shall discuss "man". I think I shall avoid the whole subject, as so surrounded with prejudices'. All of which means that the botanist or zoologist classifying his dead specimens was too little interested in their life and their evolution. But the man in the street (or the pulpit) was too much interested in evolution, in his own evolution. He was interested in it through having read Lawrence and two more recent writers, Robert Chambers and Herbert Spencer. Who were they?

Chambers and Spencer, both of them versatile, inquisitive and well-informed men, were poles apart in their thought. It was from the evidence of fossils that Chambers had discovered evolution. He wrote for the unacademic and technical reader. In his zeal for educating others and expressing himself, he was as capable of writing a life of Jesus as a work on geology. But naturally he wished to reconcile the two, to reconcile science with religion, natural history with creation. Spencer on the other hand had discovered evolution from literary sources. He wrote for an intellectual audience. And he had no desire to reconcile science and religion. It is to Spencer that we owe some of the most telling English words and phrases in evolutionary theory: first 'evolution' itself, later 'heredity' (in place of Darwin's 'organic inheritance') and the 'survival of the fittest' (in place of Darwin's natural selection).

The two men had this in common, however, that they were self-taught and self-employed. They were free from academic prejudices and limitations. But Chambers was a publisher. He was so successful a publisher that he did not feel quite free of his public. He thought it prudent in broaching this dangerous subject to write 'in solitude' as he puts it, to conceal his authorship, and to publish with another house. With strenuous

precautions he posted his manuscript from Edinburgh to Manchester where a friend posted it on to the firm of Churchill in London. It was published under the full title of *Vestiges of the Natural History of Creation*.

The results were more important than scientific historians have been willing to admit. Chambers was equally effective in his manner of presenting geology and in asking once again Descartes's philosophical and penetrating question: would it not be easier to believe that life as a whole developed gradually just as the individual life develops gradually?

In expounding their views the two outsiders, we have to admit, made various mistakes which damaged their reputation with academic men. They both failed to notice the arguments against the inheritance of acquired characters. This was perhaps not so serious for later Darwin was to fail in just the same way. More serious was their failure to respect the divisions of the animal kingdom. Eminent zoologists felt (and some perhaps still feel) that these divisions are eternal. To doubt it was to show a lack of reverence not only for the work of the Creator but also for the achievements of the comparative anatomist.

Academic scientists thus had more than one reason for abiding by the theory of creation. That the theory should be disputed by unprofessional men was in any case irritating. That it should be disputed, popularly, successfully, and apparently on quite insufficient evidence was all the more irritating. And Huxley was irritated by the *Vestiges*. He reviewed the book as he later said 'with needless savagery'. He enjoyed attacking the idea of evolution with the style and force which he later matured as its defender.

What was the effect of this professional rejection? For the general public, very little. Its anonymity stimulated interest and the authorship was plausibly conferred on Prince Albert or

Charles Lyell. Four editions of the *Vestiges* in the first year were followed by eight more. This was a greater popular success than even Lawrence's suppressed work had achieved. It was also a greater success than Darwin's work was to achieve.

Official, academic and clerical unanimity was unable with all its strength, with all its totalitarian cohesion, to hold down the explosive force of unofficial unacademic and anti-clerical thought. And the struggle was fundamentally a struggle between classes as much as a struggle between science and religion.

At the same time that this public argument was proceeding, the opposite approach, an academic approach and of quite a new kind, was being tried. It came from the most strictly professional source, from the Natural History Museum in Paris. In 1852 a French botanist, an experimenter with great horticultural experience, Charles Naudin (1815-99), published in his own journal, the *Revue Horticole*, a purely scientific account of the very same doctrine as Darwin's. Natural selection based on the analogy of artificial selection would account for Lamarck's grand scheme of evolution without using his untenable assumptions (Appendix II, 5).

Naudin's publication fell flat. The academic world was not interested. How little they were interested is shown by the fact that the sharp eyes of Joseph Hooker picked out Naudin's work only seven years later, following the appearance of the *Origin*, and after Naudin had republished it. It was Hooker who told Darwin about it. Thus though the general public was interested in evolution the academic public was not. And in England no professional scientist had addressed himself to the general public in favour of evolution since Lawrence's work had been suppressed.

Such, then, was the cause of the deadlock. We are reminded

of Talleyrand's opinion that war is too serious a matter to be left to generals. Science, when it deals with the greatest of all issues, the origin of life, is, or was, too serious a matter to be left to specialists. It was only by a joint effort of all the diverse competent elements in society that the iron framework of religious-social belief was to be broken.

An indispensable factor in securing this joint effort was to be Darwin's strategy, partly planned, partly derived from the accident of Wallace's intervention. The elements in this strategy were, first, that the statement must leave out man. But it must cover in detail the whole field of the evidence apart from man. Secondly, it must be strictly academic in style. But it must be available to the widest public. Thirdly, it must be a little loose in its definitions and its arguments. For a line of retreat might be useful at some stage in the discussion. Lastly, it must appear to be quite new and unique, acknowledging no connection with anyone else. These were the paradoxes on which the *Origin of Species* was based.

BUTLER'S PICTURE

FOR most writers on Darwinism the theory is sufficiently defined by the *Origin of Species*. Here is the book, they say. Read it. For preference, read the sixth edition, the most mature presentation. This is the view given us by the most useful historical accounts in the nineteenth century; for example, by Henry Fairfield Osborn's work published in 1894. These accounts were written by disciples deeply aware of the debt they owed to the author of the *Origin of Species*.

The other side of the picture is shown us by only one writer, Samuel Butler. The author of *Erewhon*, having fallen out with Darwin, wrote five books aimed at destroying what he held to be the myth of Darwinism.

The last work in this series was published three years after Darwin's death. Its title *Luck or Cunning* referred not to the causes of Darwin's success but to Butler's views on evolution. It referred to his opinion that inherited memory, habit or skill was the alternative to selection as the means of evolutionary change. One part of the book is concerned with arguing this case; this part does not concern us. The other part is a purely literary dissection of the origins and progress of Darwin's work; this part concerns us very much.

Butler points out the long tradition of non-acknowledgment in the scientific treatment of evolutionary theory. Lamarck in propounding the theory of evolution by direct or nearly direct adaptation in 1809 neglected to refer to the earlier

writings of Buffon or Erasmus Darwin which had the same purpose as his own. Patrick Mathew, in reviewing evolution and proposing the alternative of natural selection to account for it in 1831, did not refer to the earlier work of Lamarck or Darwin or Buffon. And as for Herbert Spencer, he began his first *Essay on Evolution* in 1852 with the words: 'Those who cavalierly reject the doctrine of Lamarck'. But when he republished it in 1858 he cut out the reference to Lamarck. 'The bad example', Butler says, 'betrayed Mr Darwin into doing as they did.'

From later evidence we can now confirm Butler's judgment. In his short draft of 1844 (published only in 1909) Darwin refers to Lamarck six times. The references do not concern theory but merely points of detail which, however, show Lamarck's understanding of large issues. Only one of these survives in the *Origin of Species* of 1859.

In the first edition of the *Origin*, as we saw, Darwin had given the impression that the problem of evolution first came to his notice on the voyage of the *Beagle* and that this was the beginning of his own ideas on the subject. Naturally his critics seized upon this apparent misrepresentation and in his third edition (1861) Darwin wrote an 'Historical Sketch'. Butler described this essay as 'meagre and slovenly'. Its stilted phrases read indeed like an unhappy confession. It is also a gravely misleading confession. In this sketch Darwin gives a slight account of Lamarck. To his grandfather Erasmus, however, he refers only in a footnote. 'It is curious', he writes in a more than usually awkward phrase, 'how largely my grandfather, Dr Erasmus Darwin, anticipated the erroneous grounds of opinion and the views of Lamarck.' He had already excused this unfortunate view in a letter to Huxley written in June 1859 with the phrase: 'the history of error is unimportant'.

Darwin's vast unacknowledged debt to his predecessors has to be admitted on Butler's evidence. But the precise sequence of ideas and arguments by which Darwin was persuaded to put evolution and natural selection together has not been clear. The finishing stroke has recently been accomplished by Loren Eiseley. It depends on Eiseley's discovery of the use Darwin made of another unacknowledged and hitherto almost unsuspected source. This is in the work of a young contemporary, the Londoner, Edward Blyth.

What was the work of Blyth? This remarkable naturalist from his chemist's shop in Lower Tooting wrote three articles on heredity, variation and selection in nature and in domestication. They appeared in the *Magazine of Natural History*, between 1835 and 1837. His argument consists in an examination of the great ideas of selection, artificial, natural and sexual, and the struggle for existence, which he might have picked up from Erasmus Darwin or any of his successors, such as Lawrence and Prichard (whom he cites). Blyth attempts to show how these ideas can be used to explain, not the change of species which he was anxious to discredit, but the stability of species in which he ardently believed.

In the course of his argument Blyth closely examines each of the problems which was to occupy Darwin's mind during the following forty years: blending inheritance as against mutation, the inheritance of acquired characters, geographical isolation, geological successions, island faunas, the origin of instinct and so on. In all these relations Blyth quotes a wealth of examples from his own observations of nature. These afterwards appear repeated, or indeed copied, by Darwin in his preliminary essays of 1842 and 1844.

The evidence quoted by Eiseley shows us that in the *Origin* Darwin is arguing against an invisible and absent opponent.

Blyth, whom he does not cite, was employed far away in Calcutta from 1841 to 1862. Further it also shows us that when Darwin refers to Malthus as his inspiration in his essay of 1858 and later in his autobiography, he is choosing to avoid mentioning his significant inspiration which was Blyth.

All these things were unknown in Butler's time to which we must now return.

When Butler's first attack appeared, Huxley came forward discreetly in Darwin's defence. He did so by writing a valuable if not profound history of evolutionary theory which was curiously combined with a history of embryology (1878). In this essay he unfortunately relied on Darwin's own reference to his grandfather and dismissed Erasmus accordingly. Only after Darwin's death did Huxley read a little (probably very little) of Erasmus himself, and in a new edition of his *Essays* (1893) he corrected his judgment of 'that ingenious writer'.

Not everyone, however, was so easily misled. In 1872 the eleventh edition of Lyell's *Principles of Geology*, a book which was one of the foundations of the new evolutionary theory, included a statement 'in justice to Lamarck'; that is to say in correction of Darwin. Similarly Haeckel's *History of Creation* in 1868 included the comment: 'The theory of development (i.e. evolution) ... is now generally (though not altogether rightly) regarded as exclusively Mr Darwin's theory.' Further: 'We must distinguish clearly (though this is not usually done) between ... the theory of descent (Lamarck) and Darwin's theory of natural selection.' In other words we must distinguish, as Darwin usually failed to do, between the historical question of what has happened and the experimental question of how or why it has happened.

It was in the light of these criticisms, according to Butler, that Darwin changed his style. 'My theory' appears forty-five

times in his first edition of the *Origin of Species*. In successive editions 'my' is gradually deleted. By the sixth edition of 1872 it becomes 'the theory' in forty-four of the forty-five cases.

This reconstruction of a proposition must be unique in the history of literature. It is certain that it is uniquely important. For in the same moment it reveals Darwin's character and it obscures for ever his mind and his meaning. There was still nothing to show which of the two questions 'the theory' was referring to. This confusion, we may suppose, was not only what Darwin wanted. Nobody noticed it, before Butler, and nobody cared. It was (and this is the strangest circumstance in the story) a confusion which his friends and his enemies were obviously agreed in wanting. How could this be so? Darwin's scientific friends wished to imagine that only Mr Darwin's new illumination had convinced them of the absurdity of the creation theory which, like their opponents, they had so long and so fondly held. And Darwin's enemies were glad enough to believe that Mr Darwin was unique and original in his own absurd and dangerous opinions. And neither side (including Darwin himself) knew what to do about the technical problem of heredity and variation which had to be dealt with in asking how evolution had occurred.

Thus in public the problem of whether evolution had occurred (which should not have been Darwin's problem) gradually pushed into the background the problem of how it had occurred (which should have been Darwin's problem). And Darwinism came to mean evolution not natural selection.

This was fortunate for Darwin because, while the change was taking place, he was engaged in retreating from the theory of natural selection. 'The theory' was coming to mean something different. And it was doing so for two reasons, neither of which Butler understood.

8

THE RETREAT FROM NATURAL SELECTION

THE dangerous objections to Darwin's theory were, as we now realize, likely to be objections from men trained in the mathematical treatment of scientific problems, that is to say from physicists and engineers. And it was precisely from such men that Darwin's difficulties arose.

The first has been recently described by Eiseley. It does not now greatly concern us. Sir William Thomson (Lord Kelvin) had been interested long before the *Origin* in the problem of the age of the earth. And when the *Origin* appeared, he quickly saw that his estimate was too short for what the geologists imagined or the biologists required. In a series of statements he asserted his view, which was based on pre-radio-activity assumptions with regard to the rate of cooling of the solar system. The age of the earth which he was willing to restrict to 30 million years had to be more like 300 million years to satisfy geology or biology. By the irony of time the radio-active isotopes of the physicist now enable us all to agree on a value extended to something like 3000 million years.

Thus Thomson was wrong and the biologists were right. The evolutionary theory was unscathed and in the end it was vindicated by the understanding of radio-activity.

But working with Thomson at Glasgow in 1859 was a younger physicist who had inherited broad intellectual interests, a controversial turn of mind and a great literary gift. This

was Henry Charles Fleeming Jenkin whose biography was later to be written by Robert Louis Stevenson. Thomson and Jenkin evidently discussed together, both as scientists and as liberal Christians, the objections to the biological theory. In due course when Jenkin went as Professor of Engineering to London he prepared a summary of the arguments against evolution in general and the theory of natural selection in particular.

Jenkin did not offer any constructive alternative such as the 'creative design' he probably had at the back of his mind. But his argument was always lucid and sometimes brilliant. What is more, on one point (which Darwin had missed) it proved to be clear and right. He says variation may be of different kinds. If it is continuous and differences blend in heredity, as Darwin supposes, it follows that any new variation in an animal will be swamped in the next generation by crossing back to the older type. It will not be able to persist long enough to enjoy any selective advantage its difference may offer. Unless, that is, it occurs repeatedly and persistently and in the same direction. Unless, indeed, it is not fortuitous as Darwin imagines.

On the other hand, Jenkin continues, variation may be abrupt and discontinuous. It may consist of 'sports' or as we now call them 'mutations'. The character of such sports may then be inherited by all the offspring without any blending. But this, says Jenkin, is not the Darwinian theory. Indeed 'it might be termed a theory of successive creations'.

Darwin never seems to have referred to Jenkin's argument in his books. But he deferred to his opinion. Steadily he began to shift his ground away from natural selection. Retreating in good order he fell back on the assumption that acquired characters were inherited. The action of the environment in changing

heredity constituted the 'persisting' cause of variation. It not only *caused* the variation: it now also *directed* it. The environment pushed a soft heredity. And when it had produced the variation the result was hard enough for natural selection to pull it further and to preserve it.

The change to this new theory was produced by imperceptible modifications of successive editions. Darwin's friends noticed the changes, however, and noticed that they made his theory very like what had been said fifty years earlier. Darwin himself must have felt uncomfortable for he now proceeded to do something Lamarck had never attempted. He set to work to invent a mechanism for Lamarckian inheritance. He supposed that changes in the environment and use or disuse affected the parts of the body concerned. From these parts the products of these effects condensed in the germ cells. This process of condensation was hard to reconcile with the advance of biology in the last thirty years. It was particularly hard to accommodate to the cell theory.

Darwin did not feel bound, however, to take notice of contemporary biology. Outside his own range of observation, he showed himself firmly traditional. But again his friends raised difficulties. Lyell and Wallace objected. One correspondent explained that the theory was as old as Hippocrates. Huxley pointed out that Buffon had had a similar hypothesis of organic particles diffusing from the whole body to the germ cells. Darwin replied that Buffon's description was 'laughably like mine' but that on Buffon's views each cell did not throw off its own 'little bud' as he supposed. Nobody seems to have noticed that Aristotle had refuted the theory with an elegant and unanswerable argument in *De Generatione Animalium*.

Darwin published his new hypothesis under the title of 'Pangenesis' as a concluding chapter of *Animals and Plants*

(1869). Here he referred to Buffon in a footnote. But the credit, or rather the discredit, for Pangenesis was a small matter. The great matter was that Darwin had now adopted a mixed theory of directed-plus-selected-evolution. 'My theory' of evolution had become very difficult to distinguish from anybody else's theory of evolution.

The new mixed theory required a readjustment of all Darwin's writings. In *Animals and Plants* where natural selection had been mentioned the direct effects of climate, habit and use had been added. No evidence of course was quoted, for of evidence there was none. Indeed *Animals and Plants* contains an account of hard heredity (in man, curiously enough). It is as exact and convincing an account as can be found anywhere today. Similarly changes of theory but not of observation were introduced into the *Origin of Species*. In the later editions, which are those usually reprinted today, natural selection has been fully bolstered and shored up with Lamarckian inheritance. But the Historical Sketch has not been revised in keeping. In the same book we therefore find, on the one hand, statements rejecting Erasmus Darwin, Lamarck and Herbert Spencer and, on the other hand, 'the theory' which was now so largely mixed up with theirs. Indeed it was mixed up, as Butler points out, with Darwin's own earlier beliefs; for he had written in *The Voyage of the Beagle*: 'Nature by making habit omnipotent and its effects hereditary, has fitted the Fuegian for the climate and productions of his country.'¹

Even in September 1857, that is in his last statement before he received Wallace's article from Ternate, he had written to Asa Gray: 'Selection acts *only* by the accumulation of slight or greater variation, *caused by external conditions*, or by the mere fact that in generation the child is not absolutely similar to the

¹ First edition 1839, p. 237, chapter 10; cut out of second edition 1845.

parent' (my italics). Here we see the two strings of the bow separately named but not quite separated. Were both of them the *only* string or was it only one of them? This ambiguity growing in intricacy became the mode and standard of Darwin's expression. It expresses the enduring dilemma which had delayed so long the appearance of the *Origin of Species*. At the same time it carries us along towards the agreement to inquire no further about the prickly problems of heredity, variation and selection, the agreement which in the end soothed and satisfied the troubled world.

9

MAN AND MORALS

THE theory of natural selection as stated by Darwin's predecessors, if not by Darwin himself, may seem simple and self-evident. It assumes that man breeds not all his peas or pigeons but only certain of them which he selects because varying at random they differ from their brethren in appearance and, as he supposes, in heredity. In this way he produces new races of peas and pigeons. In the same way nature breeds not from all plants and animals but only from selected ones, again varying at random in heredity from the rest. In this way nature produces new kinds, new species, of plants and animals. Variation takes place from unknown causes, in all directions, for better and for worse. Nature thus selects those products of variation she favours and discards or eliminates those she does not favour, just as we do. What could be more harmless or more obvious!

But put against the background of the popular, traditional alternative which Darwin's six predecessors meant it to displace — the theory of providential or guided or automatic progress — this idea takes on a sinister complexion. For the 'nature' it calls upon to undertake the work of selection, unlike man, has no purpose and no goal. Variation likewise being by chance has no purpose and no goal. The changes nature favours are not predestined to be improvements. They might often be failures. Often indeed the evidence shows that

they are gigantic failures. Progress is not inevitable. Instead of a convergence on desirable ends we are offered only a divergence, a horribly erratic divergence, from unknown beginnings. Instead of a spiritual guidance there is a material determinism in whose operation blind accident plays a necessary and morally meaningless part.

Thus the conflict between natural selection and automatic or inherent or providential direction is deeper and more abiding than the parallel conflict between evolution and creation. And it is far more important today. For the argument about evolution or creation concerns the dead past; but the argument about selection or direction concerns us now: it concerns the present we know and the future we expect.

It was for these reasons, although never expressed, that Darwin postponed dealing with the problem of man. The theory of variation had already led to trouble in the relatively quiet field of animal evolution. If man was to be represented in his whole moral and religious character as the product of processes of random change and natural selection even fiercer opposition would be aroused.¹ Eventually he faced the issue. Twelve years after the *Origin of Species* he published the *Descent of Man*. Now he was well protected not only by a devoted body of disciples but also by his double theory of heredity. Now he had a hard heredity which could vary and be selected. But he also had a soft heredity which could be pushed and directed. And he had a theory of pangenesis which could explain in terms of imaginary gemmules how it was directed.

What was his argument? He maintained that man was

¹ Fortunately neither side knew that there were random or uncertain processes in heredity also.

derived from a single stock of monkey-like animals inhabiting the old world. He maintained that this single stock had been diversified into numerous species or sub-species or races (which-ever you liked to call them). These groups were distinguished from one another in physical and mental, emotional and moral character in ways that were partly but not entirely adapted to their environments. They were also adapted or acclimatized (by heredity and by natural selection) to resist the diseases of the countries they lived in, as had been proposed fifty years earlier by the medical evolutionists following his grandfather's suggestion.

Looking back today at these arguments we might suppose that Darwin would have no difficulty in making his case, leaving open as he does the question as to whether adaptive change is due to natural selection or to direct action.

Nevertheless he runs into trouble, and he admits it. With his double theory he expects perfect adaptation. But he does not find it. He finds that people do not fit into their environments as they should do. 'If we look at the races of man' he writes (I, 246) '... their characteristics cannot be accounted for by the direct action of different conditions of life, even after exposure to them for an enormous period of time.' 'The unclothed Fuegians live on the marine productions of their inhospitable shores; the Botocudos of Brazil wander about the hot forests of the interior and live chiefly on vegetable productions; yet these tribes resemble each other so closely that the Fuegians on board the *Beagle* were mistaken by some Brazilians for Botocudos.'

Not only this but the Botocudos and other tropical American peoples are 'wholly different' from African negroes who live in a similar climate and have 'nearly the same habits of life'.

We know, as Lawrence and Prichard knew, the reasons for these inadequacies of adaptation. The native American peoples have a range of variation which is limited by the selective processes working at their origin. For it is only a thousand generations since they crossed into America and were sieved, as it were, through the climate of the Behring Straits. They arrived in small numbers and small variety. Heredity being so very hard, variation being so utterly undirected by the environment, they have not had time to adapt themselves to the whole range of conditions of the continent. The European, African and Asiatic peoples, on the other hand, have had fifty times as long to vary, to be selected and to adapt themselves to their diverse native climates. And this is why, when ships could carry them across, they so quickly replaced the native peoples over most of the American continent.

So much for physical qualities. The part of Darwin's argument which he devotes to the evolution of man's moral qualities is equally critical for the scientific questions of natural selection, whether it occurs, and heredity, whether it is hard or soft. And it is much more critical for the political question of the fate of the theory. Darwin sees man as arising from a primitive stock with strong social instincts. These instincts are determined by heredity. They have been acquired by natural selection. And they will favour the survival and multiplication of the groups which have the instincts most appropriate to their social habits (II, 391).

He gives a delightfully personal analogy: 'A pointer dog, if able to reflect on his past conduct, would say to himself, I ought (as indeed we say of him) to have pointed at that hare and not have yielded to the passing temptation of springing on and hunting it.' The instincts of such a dog provide it with the beginnings of conscience. Our moral sense, by analogy, is

compounded of inherited social instincts and of the intellectual gift, likewise inherited, of reflecting on our past experience and using it to decide on our future conduct.

Darwin's views on instincts, and especially the social instincts, were new and fundamental. They were his one profound contribution to the study of man and society. That is because they were entirely based on hard heredity. Now they may seem reasonable enough to educated people today. But to most of Darwin's original readers they would have a materialistic flavour. It was therefore, I suggest, as a precaution that he went on to disguise this crude taste. 'Social qualities', he writes on other pages, 'were no doubt acquired by the progenitors of man ... through natural selection *aided by inherited habit*' (I, 162). Again: 'It is not improbable that virtuous tendencies may through long practice be inherited' (II, 394). Here we see the flavour concealed by a pinch of soft heredity in each dose of the treatment.

And finally on the last page of his book Darwin concludes that although 'social instincts, which afforded the basis for development of the moral sense may be safely attributed' to natural selection, yet 'the moral qualities are advanced, either directly or indirectly, much more through the effects of habit, the reasoning powers, religion, etc.' (II, 404).

Where are we now? In the last sentence Darwin, with the phrase 'directly or indirectly', slips into a double disguise. He puts together without distinction the known transmission of culture, religion, etc. and the unknown inheritance of acquired characters as the joint antithesis of natural selection. Thus, even the parson might suppose that his preaching contributed to evolution; and contributed moreover to a particularly progressive and hopeful form of evolution.

Was the confusion here a confusion in Darwin's mind? Did

he imagine he had any evidence for his conclusion? If so why did he not quote it? It would have been epoch-making.¹ Or was he, on the contrary, unconsciously introducing confusion to throw ignorant people off the scent: to keep the serious discussion between people who were interested in the scientific problem? The immediate context favours this view as well as the autobiography. Take an example from the previous page.

'Man scans with scrupulous care the character and pedigree of his horses, cattle and dogs before he matches them; but when he comes to his own marriage he rarely, or never, takes any such care ... Both sexes ought to refrain from marriage if in any marked degree inferior in body or mind.' And again: 'as Mr. Galton has remarked, if the prudent avoid marriage, whilst the reckless marry, the inferior members will tend to supplant the better members of society' (II, 402, 403).

Here there is nothing about 'religion, etc.' making good the consequences of undesirable propagation. On the contrary we are given just plain selection theory: moral character varying; its variations inherited and selected; and its selection determining the development of society and the species. Fifty years earlier Lawrence had been rejected for saying these things. But now it was mixed with enough of the other stuff to be swallowed in comfort.

Do not, his father had warned Charles when he got married, do not tell your wife that you have doubts on religion. But we now know that as the years passed by the truth dawned on Emma. The beliefs of her husband, her now invalid husband, were not what a Christian could approve of. This disapproval, which may well have been the persisting cause of his chronic

¹ Galton in the following year made a statistical inquiry into the 'efficacy' of prayer in regard to the survival of sick children (reprinted 1883). But no one, so far as I know, has yet tested the inheritance of its effects.

illness, resulted, after his death, in the pruning of his Autobiography. And it must have been one of the anxieties at the back of his mind as he mixed his arguments in the *Descent of Man*. Private happiness and public policy both demanded a judicious equivocation.

10

THE GENETICAL SOLUTION

OUR next problem is to see how the development of science, to be precise the development of genetics, since Darwin, affects our interpretation of his work. This development springs from two sources, both German: Gregor Mendel and August Weismann.

The work of Weismann was later in time but it was the first to be publicly known. It consisted in a series of essays which were condensed in to the five years immediately following Darwin's death.

Weismann, like everyone else, was unaware of the earlier downright repudiation of Lamarckism in England. Consequently he refers to the transmission of acquired characters as having 'hitherto been assumed to occur'. What experimental evidence, he asks, is there for such an assumption? And he answers that there is none, none beyond various collections of loose arguments and old wives' tales. Further, the assumption is repeatedly found to be inconsistent with facts of common knowledge.

Most of Weismann's facts should have been obvious to Darwin. Others were new. For example, Weismann argues, if great abilities arose through an exercising of the talents they would accumulate over many generations. They would reach a climax at the end of a family line. But in fact hereditary genius (he quotes the Bach and Bernoulli families) usually reaches a

climax in the middle of a line. And, if it does not, it appears alone or at the beginning (as with Gauss or Handel or Titian).

Having knocked out the Lamarckian (or Hippocratic) legend, Weismann's next step, two years later, was to build up an alternative theory. He notes that new types or new characters seem to arise only in new individuals produced by sexual reproduction which in this respect he contrasts with asexual or virgin reproduction. They arise by a recombination of the hereditary or genetic materials or 'germ-plasms'. This recombination, he suggests, always occurs in sexual reproduction. Further, this recombination is due to a process of halving or 'reduction' of the genetic materials which gives different results in every germ cell. Every egg or sperm will, according to Weismann, contain a different, a unique, genetic combination. Hence the differences we all see between brothers and sisters; hence also the identity of one-egg twins already noted by Francis Galton.

Weismann in these essays was aware of the microscopic studies of nuclei and chromosomes whose later development was to fulfil his predictions and confirm his theories. He was unaware, however, that twenty years earlier, while Darwin was actually working out his theory of heredity, the breeding experiment whose results were to be fused with the chromosome observations was already being carried out. This breeding experiment was the work of Mendel.

Mendel's observations, the results of work begun in 1856, were published in 1866. Mendel's conclusions on the mechanism of heredity, like Weismann's, contradicted the assumption of blending which Darwin had made in the *Origin of Species*. But they were brought to light only in 1900.

By crossing different pure-breeding self-fertilized races of peas Mendel showed that the first generation was always

uniform. But, if this in turn was self-fertilized, its progeny, the second generation, was always highly diverse. This second generation showed recombination of all the properties or characters in respect of which the first parents had differed.

From these observations Mendel concluded that the first generation plants must all have had a double heredity. And indeed all plants and all animals must have a double heredity. They must contain double hereditary units or elements which separate when the germ cells are formed and recombine in the next generation unimpaired by the mixing they have undergone in any hybrid. Thus, according to Mendel, nature moves by jumps. Variation is not continuous; it shows discontinuous or particulate differences. And these differences do not blend any more than atoms or molecules blend. They remain intact generation after generation.

Mendel read his paper before the Brünn Natural History Society in February and March 1865. As in the case of the papers of Darwin and Wallace or the article of Naudin, there was no discussion. A scientific audience is usually warmed by a small discovery but it is chilled by a large one. Those who read the published paper put it down without comment. In the learned libraries it lay unread. And Mendel himself, probably in the same mood as Lawrence when his work was suppressed, decided never to say another word about the matter.

We may ask, however, and it often has been asked, what Darwin would have thought of Mendel's work if he had known about it. Fortunately, however, Darwin has answered this question for us. For Charles Naudin, who had expounded evolution by natural selection in 1852, announced the results of his experiments on the hybridization of varieties and species in 1861. They lay three years in the archives of the museum

before they appeared in print. They then revealed, a year before Mendel, the same principles that Mendel also discovered. Naudin drew the following general conclusions.

First generation hybrids are uniform even in reciprocal crosses; and they are often sterile. Second generation hybrids show a whole range varying in character between the two parents; and they are usually less sterile than the first generation. These results were due to the fact that the hybrid plant was double and two 'essences' derived from opposite parents separated in the pollen and in the eggs of the hybrids. Naudin further made single-grain pollinations in *Mirabilis* and proved (as Mendel did) that one grain gave one seed.

On the presentation of his paper Naudin was elected a member of the Academy of Sciences. The faithful Hooker promptly tells Darwin about Naudin's work and Darwin's comment (September 13th, 1864) is recorded:

I cannot think it will hold. The tendency of hybrids to revert to either parent is part of a wider law ... that crossing races as well as species tends to bring back characters which existed in progenitors hundreds and thousands of generations ago. Why this should be so, God knows.

On Darwin's view, Naudin's conclusions were invalid. Darwin did not distinguish between one-grain and two-grain pollinations. He believed in mass effects. He did not distinguish between first and second generation hybrids. He had never made any himself. The cellular basis of reproduction and heredity which had been revealed in the previous thirty years as we have seen, he had never tried to grasp. And in consequence the particulate theory of heredity that follows from it was completely foreign to his mind.

Why a particulate theory was foreign to Darwin's mind we see if we turn back now and look at Mendel's original paper. We then find a remarkable relation with the great issue that Darwin had evaded or shelved. It is that in the face of Mendel's principle of permanent units, or elements, or genes, which are unchanged by the environment and uncontaminated even by one another, the whole Lamarckian hypothesis and the theory of soft heredity resting on it falls to pieces.

First, as Fisher has explained, Mendelism makes evolution by selection workable. Fleeming Jenkin's objection to selection with blending inheritance was sound. But it does not hold against Mendelian inheritance. For the genes are not soft; they do not blend. They stand firm to be tested by selection. And the recessive gene, concealed by the dominance of its alternative, can come back again and again and again to be tested. It has indeed that power of 'persistence' which Jenkin and Spencer supposed that any variation must have if it is to establish itself.

Secondly, Mendelian interpretation makes evolution by direction, by Lamarckian change, inconceivable. For the alternative elements or genes are now found to lie together in the nucleus of every living cell of the hybrid plant or animal. There they are throughout life agreeing, or failing to agree, or even acting in opposition, on the same process of every cell in the body. Yet they cannot be found, or not one in ten thousand can be found, to alter one another's character or structure. If each gene stands firm within its nucleus how can we expect it regularly to yield to the slightest fluctuations outside the nucleus, outside the cells, even outside the whole organism? And according to a uniform law responsible for all adaptation? In fact Mendelian experiments show that genes do not yield, and chemical analysis explains why they do not yield. The

genes are utterly hard and they have an inflexibly self-propagating chemical structure which accounts for their hardness.

Now out of Mendelism and Weismannism (as well as out of Darwinism) has developed genetics. And there are other more recondite respects in which genetics destroys the foundations of any theory of directed variation (or soft heredity) as a basis of evolution. Two of these may be mentioned.

First, hardly any changes in the genes are directly related to their results. Every gene interacts with every other in development. Hence to reverse the process so as to change heredity to fit a given environment would be like trying to make a complex railway time-table read backwards. There would be collisions at every junction and the passengers would spend more time in the stations or in hospital than on the trains.

Secondly, many evolutionary changes benefit only posterity. They look ahead. As Lucretius pointed out, they meet needs which have not yet arisen. They are pre-adaptive. They cannot, therefore, be reactions to these needs. This is true of the origin of sexual reproduction and of recombination. It is indeed true of the whole of the evolution of genetic systems foreshadowed by Erasmus Darwin.

Students of genetics, bent on rigorous experiments, have been inclined to overlook some of the paradoxes by which their work is connected with heredity and variation in nature and hence with Darwin's theory. They have been interested in showing that changes in the chromosomes and genes of an egg determine the character of the organism which arises from it. In other words these changes are expressed in the appearance and behaviour of the organism. But as more and more complicated situations reveal themselves in nature we find that a larger and larger proportion of variation is *not* expressed in living organisms. It is concealed. Indeed the system of out-

breeding, exactly regulated outbreeding, which is characteristic of almost all plants and animals, from the microbe to the man, have the effect of concealing variation. Not only Mendelian recessiveness, but the existence of minute genes, non-specific genes, balanced genes, inert chromosomes, breakages of chromosomes, not to mention all the specificities of immunology, which are invisible to us, as Wells pointed out, all these conduce to conceal variation. They account for the ultimate paradox of cryptic or invisible species which look like one another but will not interbreed.

The appearance, therefore, conceals its heredity and its variation. The 'phenotype', as we say, expresses the genotype; but it also conceals the 'genotype'. And Darwin's problem of finding variation for natural selection to work on exists no longer. Our problem is less to explain change, which was Darwin's problem, than to account for stability, which, we may recall, was Blyth's problem. The materials for selection are continually present, concealed and stored. They are made visible and flagrantly exposed to selection by the processes of chromosome recombination which Weismann foretold. Selection then leads to change or stability as occasion demands.

Thus an apparently soft and pliable total heredity is compatible with an utter hardness in the individual particles of which this total is compounded. All changes are due to two causes: first, to changes in individual genes, changes which arise by chance with respect to any change in the environment; and secondly, to reshuffling of these genes in recombination.

The classical conflicts between the two opposed views of heredity and the two opposed views of adaptation are thus both resolved; resolved in favour of hard heredity and selective adaptation. Experimental evidence and its genetic interpretation do not allow us to doubt the effects or the efficiency of the

natural selection of variations. Nor do they allow us to assume that changes in the environment direct variation either immediately or through the responses of the organism.

Nor, again, do they allow us to say, as Darwin said, that changes in the environment increase the amount of variation and thus 'cause' it even if they do not direct it. What he is repeating here is the popular notion that domestication, by changing the environment, makes the heredity more variable, or makes the race more 'plastic'. The experimental evidence is that all the 'plasticity' (or variability) is due to the inbreeding of outbred plants and animals, or to the outbreeding or crossing of inbred plants and animals, and nothing more. It is due to changes in the system of breeding which always follow domestication, the changes whose effects Mendel studied and understood.

The radical advances in knowledge brought about by the Mendelian experiment, and by the use of the microscope, and most recently by organic chemistry, reveal endless new connections bearing on the theory of evolution. Before these advances had been made, within the classical framework of observation and inference to which Darwin confined himself, no revolutionary ideas were possible beyond what were implied by natural selection and hard heredity. And all these implications had been made clear before the *Beagle* set sail.

11

WHAT WE OWE TO DARWIN

How is it, we may now ask ourselves, that so much obscurity overhangs the development of the greatest of modern ideas? After a hundred years we are almost as uncertain of the authorship or editorship of Darwin's writings as we are of those attributed to Homer or Hippocrates. This is due on the one hand to the fact that people who investigate the history of science are historians who are not entirely clear about the meaning of its ideas. Changes in the key words of technical speech break their formal continuity. They also often believe what the discoverer writes about his own discoveries, which, as we see, is not a wise thing to do.

On the other hand among scientists there is a natural feeling that one of the greatest of our figures should not be dissected, at least by one of us. The myth should be respected. And again there is the perennial obstacle that since 1800 several paths have gradually diverged in the treatment of evolutionary problems; the biological, the medical, and the anthropological. Today the biologist is not usually interested in the races of man or the origins of language. The anthropologist is not usually interested in natural selection or the inheritance of resistance to disease. And the medical man is no longer interested, as Erasmus Darwin or Prichard were, in problems which no longer appear in the course of medical training. He no longer sees that they are bound up with his work and his place in society. None of

these people allows his love of science to carry him outside the separate ever-narrowing fields of university education.

Now it is Darwin's main work that matters to us. The details are of very little account. This main work we can accurately evaluate. We know on the one side that Darwin was wrong in supposing that acquired characteristics were inherited, that heredity was soft and therefore variation was directed by changes in the environment and flowed continuously. Heredity is in fact hard; variation is undirected and random or fortuitous with respect to its effects and it does not flow: it jumps. Still more gravely was Darwin wrong in mixing this wrong theory with his other theory which was right; for they were theories which others had clearly separated.

On the other side we know that Darwin was right in maintaining that natural selection affects the survival and reproduction of the different variations so that the character of each generation of a race of plants or animals is changed. We also have ample reasons for believing that Darwin, like his grandfather, was right in his view that all organisms have descended from a common ancestor somewhat like the simplest forms of life we now know. Throughout this descent they have maintained the same molecular apparatus of heredity and variation. They have varied and diversified and elaborated to give the immense range of species of plants and animals that we know today or that we see as fossils; and also to give vast numbers more that have disappeared without trace.

Likewise we have ample reasons for believing, as Darwin assumed, that man is just one product of this process. His remarkable mental and moral gifts are the products of natural selection. They have come into existence because they are determined by heredity, are susceptible to variation, and have been favoured by selection. Man has no spiritual gifts or social

properties or evolutionary processes which are not subject to these biological opportunities and limitations.

The question of how much of Darwin's work was new or true has been a difficult one to answer. But now we have to answer an even more difficult question: how much do we owe him for having done it and for the way he did it? Here we have to look carefully at the effects of his views. We have to consider the effects of his discoveries and also the effects of what appear to have been his mistakes. We have to compare him with those who differed from him during his lifetime.

✓ It is often said — indeed even Butler said it: Darwin convinced the world of the historical fact of evolution. This we owe him. What more need we ask? He was the apostle who converted the Christians, or a large body of them. Did he not devote almost all his life to this tremendous task? And was he not as successful in this mission *in partibus fidelium*, as any apostle has ever been?

All this is true. But it raises several other problems. The social conditions of the evolutionary crisis may come to seem as important as the individual or intellectual conditions. Again, the means used to spread the gospel or win the struggle may seem as important as the winning of it. For the future of evolution may after all prove to be as important for us as the past was for Darwin.

These problems require us to look into the consequences of Darwin's work; or some of the consequences, for as a whole they touch us in far too many places. Consider now what were the peculiar qualities in Darwin's work to which it owed its success. First, there were his skill and persistence as inquirer, observer and recorder. These gifts he directed towards a field of well-chosen dimensions neither too narrow nor too broad. Secondly, there was his independence of thought. Supported

as it happened to be by independence of economic position, he had a unique advantage over all his contemporaries.

These were virtues or accidents. But side by side with them were what I shall describe as vices. These, we now have to admit, were almost as great a help, almost as valuable a combination in achieving his success, as the virtues that accompanied them. By that I mean his public and political success in mass conversion. These vices were of three kinds: a conservative outlook in every respect except the evolutionary hypothesis; a failure to recognize or to relate his own ideas, his larger ideas, with those of others working in the same field; and a flexible strategy which is not to be reconciled with even average intellectual integrity: by contrast with Wallace, Lyell, Hooker, Chambers or even Spencer, Darwin was slippery.

Take first his conservative outlook. This outlook was fixed during the voyage of the *Beagle*. At this period great changes were taking place in the world of science. The cell theory was taking shape in Germany. With it came the downfall of humours and essences and influences. With it came the view of atoms and particles, nuclei and cells, the view of solid structures as responsible for all kinds of determination. And with determination and causation came a decline in the need for purpose and design. Again, from the cell theory arose the experiments and the arguments of Mendel and Naudin based on the idea of single-cell fertilization. From it arose Galton's notion that twins were alike because they arose from one egg of one nature, as opposed to Darwin's notion that they were alike because they were nurtured in the womb at the same time and in the same environment. From it arose Weismann's definition of the argument against the inheritance of acquired characteristics as opposed to Darwin's idea of a diffusion of 'gemmules'.

It was Darwin's conservatism therefore that made him resist and reject the views and observations of the younger men. These were the analytical and experimental men who were born in the 'twenties and the 'thirties, the men whose disagreement with him was largely suppressed during Darwin's life out of loyalty to him or to the cause of evolution. It was this conservatism that made him even accept the tale of telephony, the ancient stockbreeder's superstition that the effect of intercourse with one male will persist; it will influence the character of a female's progeny from a later mating with another male. He would indeed accept any kind of old wives' tale so long as it would support his theory, his delusion, of pangenesis.

This conservatism of Darwin's helped him. As an old-fashioned naturalist he could present a plain old-fashioned story. His prejudices were in all respects save one the same prejudices that the public had. Perhaps we should say in all respects save two, for there was evolution and there was natural selection. But as natural selection became optional and accessory and uncertain it ceased to be an obstacle to the popular acceptance of the theory. And in its place came all the opportunities for progress, including moral progress for which Robert Chambers's and also Herbert Spencer's versions of evolution had prepared an army of would-be believers.

Darwin's second politically helpful vice was closely related to his first. It was his utter independence of other people's ideas. It seems incredible that the apostle of evolution should have been so deficient in historical sense; so much so that, although deeply interested in his own priority, he never realized that his own ideas were second hand. He thought he had worked them out himself, even when he had only sorted them out. Moreover his ideas were less clearly sorted out and less clearly expressed

and, worst of all, less strictly and less openly held and maintained than the ideas of those who first thought of them. He never faced the cardinal issue of the evidence for or against the inheritance of acquired characteristics, which is more difficult and therefore more important than the issue of whether evolution has happened. He was therefore able, as he put it, to 'wriggle'. He wriggled so successfully that in the end he did not himself know where he stood.

Darwin's independence of other people's ideas led him (and his admirers) to think of himself as a man of ideas. It led him to copy out the observations from his predecessor's writings while ignoring their theories. His own methods nourished his own illusions. He began more and more to grudge praise to those who had in fact paved the way for him. We see this very well if we compare him with his contemporaries. Chambers and Naudin both praised Lamarck at the same time that both of them rejected him. Darwin damned Lamarck and also his grandfather for being very ill-dressed fellows at the same moment that he was engaged on stealing their clothes. He ridicules Lamarck's speculations and caps them with his own. He scorns Buffon's 'fluctuating opinions' while he himself is fluctuating from one edition to another, even from one chapter to another. And fluctuating with an opportunism which he judiciously strives to conceal. The strongest expressions of natural selection are those Darwin chose to publish with Wallace's paper. The strongest appreciation of Lamarck is the one he chose not to publish at all.

In his attitude to his grandfather, it has been said, there is perhaps a personal problem. It would not greatly concern us if it had not led to the strangest episode in his personal story. As we have seen he learnt about evolution from his grandfather's writings. As a youth he may have had some misgivings about

his grandfather's irreligious views and un-Victorian conduct. Such misgivings about a radical and an atheist who would have been struck off the medical register of a later age, he might owe to a prosperous father who wished him to enter the Church. It led him, however, to give an opinion about his grandfather which has now deceived three generations. And it was not made good by his mild account of the private life of his grandfather which he used as an 'introduction' to the mild account of his scientific life by a German admirer. For the one point that we are all interested in about the two men is what the grandson owed to the grandfather and that is the one point that the grandson does not choose to enlarge upon.

Whatever the cause of Darwin's ambiguity on the subject of his grandfather, historically and strategically it was of great effect. For the suppression of Erasmus Darwin by his family ran parallel to the suppression of Lawrence by the government and the suppression of Chambers by the academic world. They ran parallel and their actions were supplementary. The total effect so far as Charles Darwin was concerned seems to have been as complete and thorough as the suppression of ideas by any professedly absolute government.

We can now see how Darwin's success was wonderfully compounded of his virtues and vices. His wide but co-ordinated interests, his systematic inquiries, and his private fortune, were all indispensable ingredients. But so also were his intellectual opportunism, his willingness or at least ability to confound theoretical issues and conceal the confusion from his indiscriminating readers by loose writing or, shall we say, by making a mystery wherever it was wanted. So also was his old-fashioned outlook which kept him in touch with the well-educated, but not too well-educated, public and out of touch with the ideas of younger men.

Likewise we can see that by taking all the credit and all the blame for 'my theory' Darwin simplified the tasks of both friends and foes. For his foes had a false excuse for concentrating their attack on one dangerous innovator and his friends had a false excuse for not having acknowledged earlier what had long been perfectly obvious to laymen like Chambers or Spencer.

The golden bridge of natural selection stood open only ten years but in that time the brighter spirits led by Huxley could cross over to the other side. To see what this golden bridge meant we have to recall the prolonged preparations that had been made to resist the coming of evolution. As the evolutionary crisis approached, already at the beginning of the nineteenth century the Church had girded itself for the struggle. Already the intellectual defences had been strengthened with Paley's *Evidences of Christianity* and *Natural Theology*, strengthened against the evolutionary attack in the writings of Erasmus Darwin. Moreover, university education in England, that is to say, both the instruction of pupils and the employment of teachers, was under the control of the bishops of the Church of England. It remained so, significantly and without relaxation, until reform came in 1856. Against new ideas there was therefore a system of defence in great depth.

It was this system of defence which threw off with spontaneous unanimity the attack of Lawrence. It destroyed Lawrence; it diverted Prichard; and it failed to destroy Chambers only for very particular reasons: namely because he did not assume natural selection; he did not advance a theory independent of divine guidance; and he was doubly protected by his anonymity and his independence as a publisher.

The part played by naturalists in this crisis was, as they later realized, not at all creditable. It seems that their prevailing

interest in giving names to species favoured a belief in their permanence and hence in their creation. 'Too much systematic work', as Darwin dryly remarks 'somehow blunts the faculties.' In these circumstances the advanced thinking came not from university or professional scientists. It came, as Geoffrey West has pointed out, from writers who were able to disguise their notions under the forms of poetry or piety. Tennyson's *In Memoriam* published in 1850 was the most read poem of the century in England. He understood geological evolution just as Browning (already in *Paracelsus*) had understood biological evolution — from 'life's minute beginnings up at last to man'.

Intellectuals were not shocked by these things. Academic scientists did not read them. They knew better. Lyell and Huxley in England, like Cuvier in France, believed in creation. Huxley indeed did not trouble to read the 1858 Darwin and Wallace papers, a fact (as Poulton points out) which emerges from his account of the reception of the *Origin*. For Huxley and for so many others, Darwin by appearing to be new, by appearing to have a message of his own in 1859, provided the excuse for their old ideas as well as the way out to their new ideas.

It was this long preparation on both sides, the climax coming just when the Church had been defeated in the English universities, that gave the excitement to the ultimate clash and the ultimate victory. And it was this excitement which gave rise to the illusions of what we may call the Darwinian myth. The belief that Darwinism was simply the work of Darwin and that its success was simply a scientific success, to be judged by intellectual criteria alone. The belief that it is concerned merely with the historical fact of evolution, that the process of evolution, the future of evolution, did not concern Darwin and, since it is so very, very slow, it need not seriously concern us.

The belief that the man who liberated mankind succeeded also in liberating himself — which unfortunately he did not. All these are parts of the Darwinian myth. If we understand them, Darwin's work becomes a base for discovery. If we do not understand them it becomes, as we shall now see, a block to discovery.

12

THE MYTH ESTABLISHED

WITH Darwin we are now in a position to claim that private vices have been public benefits. So much may be true in the short run. But in the long run we have to cast up a different account. Darwin's mixed theory, his double standard of explanation, has fathered a numerous litter of mixed theories. An illegitimate progeny of double standards has swarmed from his evolutionary statements and populated every field of the science of life.

How did this happen? The biologist may say that hard heredity and strict natural selection are the basis of his theory tested with the penetrating and exhaustive techniques of physics and chemistry and by experiments controlled with the utmost statistical rigour. He may claim that they work with success in the practice of plant and animal breeding and that they enable him to understand the most diverse problems of the evolution of man in health and in disease. He may explain that the whole of his knowledge, knowledge stretching from the chemical structure of the gene to the behaviour of identical twins or the interpretation of history, tends to exclude the alternative of soft heredity. And he may add that with this exclusion the principles of direction, design and purpose are likewise shut out.

To this argument the sceptical layman may reply that he hears much to the contrary. Did not Charles Darwin admit the

inheritance of the effects of habit and teaching? Did he not appeal to such effects to explain the origin of man's moral character? And did not Herbert Spencer exhort us to believe in the improving evolutionary effects of the environment? Have not the most learned historians repeatedly demonstrated with a prodigious weight of evidence that the greatness of nations arises directly from the challenge of their environment? And are not the best-known biologists in Soviet Russia today able to support such conclusions with experimental evidence?

At this point we must be allowed to relax our argument for a moment. What a pleasant prospect these observations open before us! No longer need man with his wonderful control of the environment bow to the terrors and hazards of natural selection. Now under an enlightened dispensation, teaching will make good all disabilities of the mind, medicine will repair all defects of the body, and congenial surroundings from the earliest age will remove all temptation to crime. Scientific experts, genuine and learned men who know what they are doing (and are fortunately never charlatans), will thus mould us into better people fit for a better world. And our children of course from the moment of conception will be so much the better for the treatment we have undergone: a nobler generation will arise.

This better world (foretold by Herbert Spencer but not by Charles Darwin) will be a world in which race, class and individuality, those inborn causes of hatred and injustice, will be submerged in equality and love. And the struggle for existence will gradually be replaced by mutual understanding. Men and women who have met the challenge of the environment so often before, will now have achieved an enduring and well-deserved peace. Who will then be able to doubt that a benevolent purpose has guided us all in this splendid advance?

It is an advance in which we are led forward in parallel columns by liberal Christians, Marxist Darwinians and an assortment of social scientists and other hopeful intellectuals.

This happy train of thought — and I hope the reader will agree that it is a happy train of thought — cannot be traced back to Darwin's observations on human races and societies or human instincts and morals. Indeed, quite the reverse. It can, however, be traced back to his general conclusion on the effects of teaching, religion, etc. It can be traced back to the general theory of Lamarckian inheritance and to the eloquent arguments of Herbert Spencer. And it is Darwin's opportunism in adopting a double theory only half of which he had grounds for accepting that is responsible for the whole biological assumptions behind this ill-assorted alliance of world optimism.

It is worth while noting in detail how some of these intellectual illusions arose from Darwin's own intellectual dislocation. The great step, the revolutionary step, which Darwin and Huxley made together was to show man in his place in nature. What place? In his evolutionary place as an animal more intelligent than his ancestors, so much more intelligent that, though his past was controlled by no purpose, his own purpose would allow him to control his future.

This was the *raison d'être* of the modern social sciences. Indeed we may date their birth from Huxley's presidency of the Ethnological Society in 1870. Yet, if we follow the history of the social sciences from that point, what do we find? Clearly there were now firm grounds for studying the evolution of society in terms of natural selection, in terms of the adaptation and differentiation of individuals, races and classes, in terms of the advantages of cross-breeding. Darwin had discussed all these matters in relation to man except the cross-breeding problem; and to this problem he had devoted three volumes in

its bearing on the evolution of plants. Only a few years earlier the significance of cross-breeding in man had been pointed out by McLennan. The time seemed to be ripe for fitting man into the biological picture. Did it happen? Not at all.

The social scientists thought the kinship rules, which ensured out-breeding in all primitive communities, had no connection with their genetic consequences. The social situation had nothing to do with the biological situation. It was something peculiarly human. But the discoveries of the last hundred years have, in fact, shown that cross-breeding is essential to evolution in all plants and animals. They have shown it in three steps. First, Darwin's discovery that out-breeding enhances the vigour of the progeny. Secondly, Weismann's and Mendel's discovery that outbreeding is necessary for the recombination of differences. And, thirdly, the discovery by genetics in the last fifty years that a prodigious variety of devices are used by different species of plants and animals in securing the regular outbreeding necessary for their evolution; by all species indeed that have a future.

These discoveries about breeding systems have provided one more example of Darwin's soundness on the smaller questions of principle, a soundness that failed him only on the largest and most dangerous issue.

Thus the breeding systems of man which have been taken to be the outstanding example of man's social uniqueness are, on the contrary, the outstanding example of his subordination to strict biological principles, the principles of recombining variation and natural selection. Man could never have evolved the social diversity of the last 10,000 years if he had not had his own instinctively, that is genetically, determined reactions to inbreeding and cross-breeding: and the tribal and kinship systems which derive from them and maintain them.

Thus, so far from the infant social sciences developing in fruitful union with evolutionary theory, they immediately began to move away. The biologists following Darwin had ceased to be concerned with the process of evolution or with experiments in heredity. Darwin's ambiguity imposed no scientific restraint on anyone who wished to claim to be his follower. Herbert Spencer had combined his spurious biology with social science. A delightful freedom of initiative was left for anyone who wished to follow his Lamarckian assumptions and to reject the evidence of any experimental inquiry.

It was the easiest thing in the world, in these circumstances, to float the social sciences off their scientific foundations and make them an independent system. And so off they sailed on their own happy voyage with their own cargo of philosophy, but unassisted by any scientific chart or compass. No longer was there any need to refer to experimental evidence, to ask how the biological theory was progressing, to compare notes outside the strictly social inquiry. Now heredity and natural selection could be wiped out, race could be expunged as a political invention, and the environment could be left supreme. The navigator could set his course by each local fashion and trim his sails to each political wind. From these beginnings the most comfortable, and also the most uncomfortable, doctrines have emerged, liberal in one country, communist in another country, nationalist in a third. Some say there is no natural selection in man; others say there are no races in man; others again say there is no evolution in man; all agree that social class either does not exist or is merely an arbitrary and temporary convention.

All these views are independent of biology but they never conflict with the prevailing climate of opinion or the dominant political illusion. They can be independent not only of biology

but also of one another. Inconsistencies which would disturb a science do not trouble the social sciences. Social anthropology in Western countries need have no more serious relation with physical anthropology than with any other science. Darwinism, a belief in the evolution of animals, is an article of faith in the Soviet Union but Social Darwinism, the application of the principle of natural selection to man, is as much a heresy as it is with Western social scientists.

With this foreground of undisturbed optimism in the general atmosphere of civilized countries it is not surprising that, in the background, the more formal processes of religion, education and philosophy have been similarly undisturbed by the acceptance of evolution on Darwin's terms. Slowly religious teachers have realized that there is nothing in Darwin's mixed theory that need worry anybody. It is entirely compatible with the view that evolution proceeds under divine guidance towards a desirable goal. If this is so, man and his morals have a character beyond experimental study and beyond animal analogy. Hence there are social and spiritual processes beyond the reach of crude scientific inquiry. The natural history of man can be ignored. Or, if you like, man's place in nature is outside nature. The principle is the same as with the social sciences. Darwin's compromise formula including the inheritance of habit saves anyone from having to accept his genuine views. Thus in the field of religion the Darwinian revolution meant a severe shaking. But when we look around us today we see that nothing indispensable has been broken; no irretrievable damage has been done.

What is even more surprising is that in the field of Darwin's own deepest inquiries, botany, zoology and geology, the universities have proved as resilient as the Churches. We expect that disciples will take some of the life out of teachings of any

master. But in our universities it is not clear that Darwinism ever came to life. The acceptance of a theory of evolution was so long overdue that when it came it merely confirmed the established programme. Classification, dissection, and description could continue. The barnacles were not in the end unhonoured.

There were, to be sure, now more resounding reasons to be given for these academic studies. Embryology began to reveal the past as well as the future. Comparative anatomy seemed to have an intellectual and not merely a technical interest. Botany revealed new and insoluble problems which might excite discussion and elude inquiry. And the study of species now came to have an occult as well as a practical purpose. The names of Huxley and Hooker, associated with Darwin and reconciled with Linnaeus, gave a glowing prestige to these studies as a training for the mind and a preparation for the responsibilities of life.

These busy doings concealed the fact that Darwin had shut the door into the experimental garden. The fate of Mendel and of Naudin, like the earlier fate of Lawrence, showed just how firmly the door had been shut and bolted against the question of how evolution had taken place. It was not that their papers had been suppressed. Everyone could read them. But they meant nothing because they attempted to answer questions that had already been answered. Had not Lawrence's questions been answered by the Church? And had not Mendel's and Naudin's questions been answered by Darwin?

All teaching quickly runs into reiteration, especially the reiteration of authority, if its growth is not regularly weeded, pruned or burnt back. Darwin by his softest and most uncertain sentences provided for the growth of the greatest certainty. For what he said meant that under the new manage-

ment the same staff would continue to be employed and the same lessons to be learnt.

How are we to sum up? As things stand today to Darwin we owe one great victory in which many men bore a part and many small defeats which were peculiarly his own. But by facing the problem that Darwin failed to face, by resolving the dilemma that he was unwilling to resolve, we can change the balance of the debt we owe him. We can, and no doubt we shall, in this way change Darwin's place in history.

APPENDIX

DOCUMENTS IN EVOLUTIONARY THEORY

I. Direction (Soft Heredity)

1. Hippocrates
2. Lamarck
3. Chambers
4. Spencer
5. Lysenko

II. Selection (Hard Heredity)

1. Lucretius
2. Maupertuis
3. Wells
4. Mathew
5. Naudin

III. Descartes on the Idea of Evolution

BIBLIOGRAPHY

- A. Primary References
- B. Secondary References
- C. The Lawrence Controversy



APPENDIX

DOCUMENTS IN EVOLUTIONARY THEORY

I. THE DIRECTION THEORY (with Soft Heredity)

I. THE HIPPOCRATIC THEORY

The races that differ but little from one another I will omit, and describe the condition only of those which differ greatly, whether it be through nature or through custom. I will begin with the Longheads. There is no other race at all with heads like theirs. Originally custom was chiefly responsible for the length of the head, but now custom is reinforced by nature. Those that have the longest heads they consider the noblest, and their custom is as follows. As soon as a child is born they remodel its head with their hands, while it is still soft and the body tender and force it to increase in length by applying bandages and suitable appliances, which spoil the roundness of the head and increase its length.

Custom originally so acted that through force such a nature came into being; but as time went on the process became natural so that custom no longer exercised compulsion. For the seed comes from all parts of the body, healthy seed from healthy parts, diseased seed from diseased parts. If, therefore, bald parents have for the most part bald children, grey-eyed parents grey-eyed children, squinting parents squinting children, and so on with other physical peculiarities, what prevents a long-headed parent having a long-headed child? At the present time long-headedness is less common than it was, for owing to intercourse with other men the custom is less prevalent.

Hippocrates, vol. I, p. 111: Trans. W. H. S. Jones. Classical Library, Heinemann, 1923

2. JEAN BAPTISTE DE LAMARCK: 1809

(i) *God's Laws*

The will of God is everywhere expressed by the execution of the laws of nature ... Nature is a power which produces, renews, changes, displaces, in a word, makes and unmakes the different bodies which constitute the universe.

(ii) *Origin of Cultivated Plants*

All botanists know that the plants they bring from their native places into their gardens to cultivate them there undergo little by little, changes which make them unrecognizable ... These effects of changed conditions are so well recognized that botanists do not like to describe plants from gardens unless they have been newly brought into cultivation.

(iii) *The Special Creation of Man*

If man were distinguished from the animals only by his organization, it would be easy to show that the properties of organization which we use to make man and his races a group apart are all the products of old changes in his actions and of habits which he has assumed and which have become peculiar to individuals of his species.

(iv) *Inheritance of Acquired Characters*

Everything that nature has caused individuals to gain or lose owing to the influence of the circumstances to which their race has been for long exposed and hence owing to the influence of the predominant use of one organ, or disuse of another; she conserves it in the new individuals which arise by reproduction, provided that the acquired changes are common to the two sexes or to the progenitors of the new individuals.

(v) *The Giraffe meets the Challenge of the Environment*

We know that this animal, the tallest of mammals, dwells in the interior of Africa, in places where the soil, almost always arid and without herbage, obliges it to browse on trees and to strain itself

continuously to reach them. This habit sustained for so long, has had the result in all members of its race, that the forelegs have grown longer than the hind legs and that its neck has become so stretched, that the giraffe, without standing on its hind legs, lifts its head to a height of six metres (nearly 20 feet).

Philosophie Zoologique: Trans. C. D. Darlington, 1953

3. ROBERT CHAMBERS: 1844

(i) *Acquired Characters*

We shall now see an instance of development operating within the production of what approaches to the character of variety or species. It is fully established that a human family, tribe or nation is liable, in the course of generations, to be either advanced from a mean form to a higher one, or degraded from a higher to a lower, by the influence of the physical conditions in which it lives. The coarse features and other structural peculiarities of the negro race only continue while these people live amidst the circumstances usually associated with barbarism. In a more temperate clime, and higher social state, the face and figure become greatly refined. The few African nations which possess any civilization also exhibit forms approaching the European; and when the same people in the United States of America have enjoyed a within-door life for several generations, they assimilate to the whites amongst whom they live.

On the other hand, there are authentic instances of a people originally well formed and good-looking, being brought by imperfect diet and a variety of physical hardships to a meaner form. It is remarkable that prominence in the jaws, a recession and diminution of the cranium, and an elongation and attenuation of the limbs, are peculiarities always produced by these miserable conditions, for they indicate an unequivocal retrogression towards the type of the lower animals. Thus we see nature alike willing to go back and to go forward. Both effects are simply the result of the operation of the law of development in the generative system. Given good conditions, it advances; bad ones, it recedes. Now, perhaps, it

is only because there is no longer a possibility, in the higher types of being, of giving sufficiently favourable conditions to carry on species to species, that we see the operation of the law so far limited.

(ii) *Evolution Continues*

Perhaps even the transition from species to species does still take place in some of the obscurer fields of creation, or under extraordinary casualties, though science professes to have no such facts on record.

(iii) *The Plan of Nature*

Early in this century, M. Lamarck, a naturalist of the highest character, suggested an hypothesis of organic progress which deservedly incurred much ridicule, although it contained a glimmer of the truth. He surmised, and endeavoured, with a great deal of ingenuity, to prove, that one being advanced in the course of generations to another, in consequence merely of its experience of wants calling for the exercise of its faculties in a particular direction, by which exercise new developments of organs took place, ending in variations sufficient to constitute a new species. Thus he thought that a bird would be driven by necessity to seek its food in the water, and that, in its efforts to swim, the outstretching of its claws would lead to the expansion of the intermediate membranes, and it would thus become web-footed.

Now it is possible that wants and the exercise of faculties have entered in some manner into the production of the phenomena which we have been considering; but certainly not in the way suggested by Lamarck, whose whole notion is obviously so inadequate to account for the rise of the organic kingdoms, that we only can place it with pity among the follies of the wise. Had the laws of organic development been known in his time, his theory might have been of a more imposing kind. It is upon these that the present hypothesis is mainly founded. I take existing natural means, and shew them to have been capable of producing all the existing organisms, with the simple and easily conceivable aid of a higher generative law, which we perhaps still see operating upon a

limited scale. I also go beyond the French philosopher to a very important point, the original Divine conception of all the forms of being which these natural laws were only instruments in working out and realizing. The actuality of such a conception I hold to be strikingly demonstrated by the discoveries of Macleay, Vigers and Swainson, with respect to the affinities and analogies of animal (and by implication vegetable) organisms. Such a regularity in the structure, as we may call it, of the classification of animals, as is shewn in their systems, is totally irreconcilable with the idea of form going on to form merely as needs and wishes in the animals themselves dictated. Had such been the case, all would have been irregular as things arbitrary necessarily are. But, lo, the whole plan of being is as symmetrical as the plan of a house, or the laying out of an old fashioned garden. This must needs have been devised and arranged for beforehand. And what a preconception or forethought have we here!

Vestiges of the Natural History of Creation

4. HERBERT SPENCER: 1852, 1858

(i) *Evolution or Creation?*

Those who cavalierly reject the Theory of Evolution, as not adequately supported by facts, seem quite to forget that their own theory is supported by no facts at all. Like the majority of men who are born to a given belief, they demand the most rigorous proof of any adverse belief, but assume that their own needs none.

(ii) *Inheritance of Acquired Characters*

Even could the supporters of the Development Hypothesis merely show that the origination of species by the process of modification is conceivable, they would be in a better position than their opponents. But they can do much more than this. They can show that the process of modification has effected, and is effecting, decided changes in all organisms subject to modifying influences. Though, from the impossibility of getting at a sufficiency of facts,

they are unable to trace the many phases through which any existing species has passed in arriving at its present form, or to identify the influences which caused the successive modifications; yet, they can show that any existing species — animal or vegetable — when placed under conditions different from its previous ones, *immediately begins to undergo certain changes of structure fitting it for the new conditions*. They can show that in successive generations these changes continue, until ultimately the new conditions become the natural ones. They can show that in cultivated plants, in domesticated animals, and in the several races of men, such alterations have taken place. They can show that the degrees of difference so produced are often, as in dogs, greater than those on which distinctions of species are in other cases founded. They can show that it is a matter of dispute whether some of these modified forms are varieties or separate species. They can show, too, that the changes daily taking place in ourselves — the facility that attends long practice, and the loss of aptitude that begins when practice ceases — the strengthening of passions habitually gratified and the weakening of those habitually curbed — the development of every faculty, bodily, moral or intellectual, according to the use made of it — are all explicable on this same principle. And thus they can show that throughout all organic nature there is at work a modifying influence of the kind they assign as the cause of these specific differences: an influence which, though slow in its action, does, in time, if the circumstances demand it, produce marked changes — an influence which, to all appearance, would produce in the millions of years, and under the great varieties of condition which geological records imply, any amount of change.

(iii) *The Scope of Evolution*

That by any series of changes a protozoon should ever become a mammal, seems to those who are not familiar with zoology, and who have not seen how clear becomes the relationship between the simplest and the most complex forms when intermediate forms are examined, a very grotesque notion. Habitually looking at things rather in their statical than in their dynamical aspect, they never

realize the fact that, by small increments of modification, any amount of modification may in time be generated.

(iv) *An Argument from Embryology*

What can be more widely contrasted than a newly-born child and the small, semi-transparent, gelatinous spherule constituting the human ovum? The infant is so complex in structure that a cyclopaedia is needed to describe its constituent parts. The germinal vesicle is so simple that it may be defined in a line. Nevertheless, a few months suffice to develop the one out of the other; and that, too, by a series of modifications so small, that were the embryo examined at successive minutes, even a microscope would with difficulty disclose any sensible changes.

(v) *Spencer attacks Owen, Lyell and Huxley*

That the uneducated and the ill-educated should think the hypothesis that all races of beings, man inclusive, may in process of time have been evolved from the simplest monad, a ludicrous one, is not to be wondered at. But for the physiologist, who knows that every individual being is so evolved — who knows further, that in their earliest condition that germs of all plants and animals whatever are so similar, 'that there is no appreciable distinction amongst them which would enable it to be determined whether a particular molecule is the germ of a conferva or of an oak, of a zoophyte or of a man'; — for him to make a difficulty of the matter is inexcusable.

The Development Hypothesis, 1852, as reprinted 1858

5. TROFIM DENNISOVICH LYSENKO: 1943

(i) *Assimilation of Conditions*

The external conditions, when they are included within, assimilated by the living body, become thereby internal, and not external, conditions, i.e. they become particles of the living body, and for their growth and development they in turn demand that food and those conditions of the external environment, which they were themselves in the past.

(ii) *Stock and Scion*

The scion and the stock cannot exchange either the chromosomes of the cell nuclei or the cytoplasm. And yet the hereditary properties can be transmitted from the stock to the scion and vice versa. Hence, the plastic substances elaborated in the scion and in the stock possess the properties of the breed, i.e. the heredity.

(iii) *The Need to Exist*

If the surrounding milieu does not contain the conditions needed for the development of some characters and properties without which the organism cannot continue to exist, such characters and properties cannot easily remain recessive. They develop perforce, so to speak, because otherwise the organism must cease to exist.

Heredity and its Variability: Trans. Th. Dobzhansky, 1946

II. THE SELECTION THEORY (with Hard Heredity)

I. LUCRETIUS: *De Rerum Natura*

(i) Genetic Particles or Determinants

*quippe, ubi non essent genitalia corpora cuique,
qui posset mater rebus consistere certa?*

For if each organism had not its own genetic bodies, how could we with certainty assign to each its mother?

I, 167-8

(ii) Recombination and Recessiveness

*fit quoque ut interdum similes existere avorum
possint et referant proavorum saepe figuras
propterea quia multa modis primordia multis
mixta suo celant in corpore saepe parentes,
quae patribus patres tradunt ab stirpe profecta.*

It can happen that children resemble their grandparents, and even repeat the characters of more distant progenitors, for this reason that parents often have concealed in their bodies many primordia,

mixed in different ways, which they derive from the stock, and hand down from generation to generation.

(Note that *primordia* here are being used in the sense of *genitalia corpora* or genetic particles.)

IV, 1218-22

(iii) Adaptation and Pre-adaptation

*nil ideo quoniam natumst in corpore ut uti
possemus, sed quod natumst id procreat usum.*

For nothing is born in the body in order that we may be able to use it, but rather, having been born, it begets a use.

IV, 834-5

2. PIERRE-LOUIS MOREAU DE MAUPERTUIS

La Nature contient le fonds de toutes ces variétés, le hasard ou l'art les mettent en œuvre. C'est ainsi que ceux dont l'industrie s'applique à satisfaire le goût des curieux, sont, pour ainsi dire, créateurs d'espèces nouvelles. Nous voyons paroître des races de chiens, de pigeons, de serins, qui n'étoient point auparavant dans la Nature. Ce n'ont été d'abord que des individus fortuits; l'art et les générations répétées en ont fait des espèces.

Nature holds the stock of all these varieties; chance or skill puts them into circulation. It is thus that those who exert their efforts to satisfy the tastes of the connoisseur are, so to speak, creators of new species. We see appearing new races of dogs, pigeons and canaries, which have never existed before in nature. At the beginning these were only chance individuals. Skill after repeated generations has made them into species.

Vénus Physique, 1746

3. WILLIAM CHARLES WELLS: 1818

(i) *Selection and Adaptation to Disease*

On considering the difference of colour between Europeans and Africans, a view has occurred to me of this subject, which has not

been given by any author, whose works have fallen into my hands. I shall, therefore, venture to mention it here, though at the hazard of its being thought rather fanciful than just.

[There is no circumstance, perhaps, in which these two races differ so much, as in their capacity to bear, with impunity, the action of the causes of many diseases. The fatality to Europeans of the climate of the middle parts of Africa, which are, however, inhabited by negroes without injury to their health, is well known. Let it then be supposed, that any number of Europeans were to be sent to that country, and that they were to subsist themselves by their bodily labour; it seems certain, that the whole colony would soon become extinct. On the other hand, the greater liability of negroes in Europe to be attacked with fatal diseases is equally well established.] If, therefore, a colony of the former race were brought to Europe, and forced to labour in the open air for their subsistence, many of them would quickly die, and the remainder, from their inability to make great bodily exertions in cold weather, and their being frequently diseased, would be prevented from working an equal number of days in the year with the whites. The consequence would be, that without taking farther into account the unfriendliness of the climate to them, their gains would be inadequate to the maintenance of themselves and their families. They would thence become feeble, and be rendered still more incapable of supporting life by their labour. In the meantime, their children would die from want, or diseases induced by deficient or improper nourishment, and in this way, a colony of the negro race in a cold country would quickly cease to exist.

This difference in the capacity of the two races to resist the operation of the causes of many diseases, I assume as a fact, though I am utterly unable to explain it. I do not, however, suppose, that their different susceptibility of diseases depends properly on their difference of colour. On the contrary, I think it probable, that this is only a sign of some difference in them, which, though strongly manifested by its effects in life, is yet too subtle to be discovered by an anatomist after death; in like manner as a human body, which is

incapable of receiving the small-pox, differs in no observable thing from another, which is still liable to be affected with that disease.

(ii) *Isolation and Race Formation*

Regarding then as certain, that the negro races are better fitted to resist the attacks of the diseases of hot climates than the white, it is reasonable to infer, that those, who only approach the black race, will be likewise better fitted to do so, than others who are entirely white. This is, in fact, found to be true, with regard to the mixture of the two races; since mulattoes are much more healthy in hot climates than whites. But amongst men, as well as among other animals, varieties of a greater or less magnitude are constantly occurring. In a civilized country which has been long peopled, those varieties, for the most part, quickly disappear, from the inter-marriages of different families. Thus, if a very tall man be produced, he very commonly marries a woman much less than himself, and their progeny scarcely differs in size from their countrymen. In districts, however, of very small extent, and having little intercourse with other countries, an accidental difference in the appearance of the inhabitants will often descend to their late posterity. The clan of the Macras, for instance, possess both sides of Loch-Duich in Scotland; but those who inhabit one side of the loch are called the black Macras, and the others the white, from a difference which has always been observed in their complexions.

Again, those who attend to the improvement of domestic animals, when they find individuals possessing, in a greater degree than common, the qualities they desire, couple a male and female of these together, then take the best of their offspring as a new stock, and in this way proceed, till they approach as near the point in view, as the nature of things will permit. But, what is here done by art, seems to be done, with equal efficacy, though more slowly, by nature, in the formation of varieties of mankind, fitted for the country which they inhabit. Of the accidental varieties of man, which would occur among the first few and scattered inhabitants of the middle regions of Africa, some one would be better fitted than the others to bear

the diseases of the country. This race would consequently multiply, while the others would decrease, not only from their inability to sustain the attacks of disease, but from their incapacity of contending with their more vigorous neighbours. The colour of this vigorous race I take for granted, from what has been already said, would be dark. But the same disposition to form varieties still existing, a darker and a darker race would in the course of time occur, and as the darkest would be the best fitted for the climate, this would at length become the most prevalent, if not the only race, in the particular country, in which it had originated.

In like manner, that part of the original stock of the human race, which proceeded to the colder regions of the earth, would in process of time become white, if they were not originally so, from persons of this colour being better fitted to resist the diseases of such climates, than others of a dark skin.

The cause which I have stated, as likely to have influence on the colour of the human race, would necessarily operate chiefly during its infancy, when a few wandering savages,¹ from ignorance and improvidence, must have found it difficult to subsist throughout the various seasons of the year, even in countries the most favourable to their health. But, when men have acquired the knowledge of agriculture, and other arts, and in consequence adopt a more refined mode of life, it has been found, that an adherence to their ancient customs and practices will preserve them long as a distinct race from the original inhabitants of the country to which they had emigrated. Examples of this kind are frequent in the islands in the eastern seas in the torrid zone, where the inhabitants of the sea-coast, evidently strangers, are in some degree polished, and of a brown colour, while the ancient natives, who live in the interior parts, are savage and black.

Similar facts occur in respect to other species of animals. It seems certain, for instance, that fine woolled sheep, like the Spanish, never both arose and sustained their breed in the northern parts of Europe; yet, by care, this feeble race, after being formed in Spain,

¹ Note the assumption of a sparse savage stage in the ancestry of man.

has been propagated and preserved in very cold countries. Thus the late Mr Dryander, the learned librarian of the Royal Society, informed me, that the breed of fine woolled Spanish sheep has been kept perfect in Sweden during a very long term of years, I think he said a century. If, then, my memory be accurate upon this point, we have here an example of a variety of animals, much more liable to be affected by external circumstances than the human race, being preserved without change, in a country very different from their own, by assimilating their new state as much as possible to their old, during at least fifty generations, that is, during a period equivalent to 1500 years in the history of man.

Hitherto, while speaking of the external appearance of negroes, I have taken notice only of their colour. I shall now say a few words upon their woolly hair, and, according to our notions of beauty, the deformity of their features.

There are several facts which seem to show, that these circumstances are somehow connected with their low state of civilization.

First; the black inhabitants of the Indian Peninsula within the Ganges, who, compared with the African negroes, may be regarded as a polished people, have hair and features much less dissimilar to the European.

Secondly; woolly heads, and deformed features, appear again, as we proceed further to the east, among the savage inhabitants of New Guinea, and the adjacent islands, at the distance nearly of half of the circumference of our globe from Africa, and consequently without the smallest probability of any communication having ever existed between the two countries.

Lastly; it appears probable from the reliques of ancient art, that the early inhabitants of Egypt were of the negro race. If, then, the negroes of Africa were ever to be civilized, their woolly hair and deformed features would, perhaps, in a long series of years, like those of the Egyptians, be changed. On the other hand, their present external appearance may possibly be regarded not only as a sign, but as a cause of their degraded condition, by preventing, in some unknown way, the proper development of their mental

faculties; for the African negroes have in all ages been slaves; and the negroes in the eastern seas are in no instance, I believe, masters of their handsomer neighbours, but are in many places in entire subjection to them, though the latter be frequently less numerous.

It will no doubt be objected to what I have advanced respecting the difference of colour between Europeans and Africans, that the Indian inhabitants of the greater part of the immense continent of America have skins nearly of one hue. Plausible reasons may, I think, be given for this fact, consistently with what has been said upon the colour of the two former races; but I forbear trespassing any longer upon the time of the reader, in discussing a subject which admits only of conjectural reasoning.

*An Account of a Female of the White Race of Mankind,
part of whose skin Resembles that of a Negro, etc.*

4. PATRICK MATHEW: 1831

(i) *The Law of Natural Selection*

The self-regulating adaptive disposition of organized life may, in part, be traced to the extreme fecundity of Nature, who, as before stated, has, in all the varieties of her offspring, a prolific power much beyond (in many cases a thousandfold) what is necessary to fill up the vacancies caused by senile decay. As the field of existence is limited and pre-occupied, it is only the hardier, more robust, better suited to circumstance individuals, who are able to struggle forward to maturity, these inhabiting only the situations to which they have superior adaptation and greater power of occupancy than any other kind; the weaker, less circumstance-suited, being prematurely destroyed.

This principle is in constant action, it regulates the colour, the figure, the capacities and instincts; those individuals of each species, whose colour and covering are best suited to concealment or protection from enemies, or defence from vicissitude and inclemencies of

climate, whose figure is best accommodated to health, strength, defence, and support; whose capacities and instincts can best regulate the physical energies to self-advantage according to circumstances — in such immense waste of primary and youthful life, *those* only come forward to maturity from the strict ordeal by which Nature tests their adaptation to her standard of perfection and fitness to continue their kind by reproduction.

From the unremitting operation of this law acting in concert with the tendency which the progeny have to take the more particular qualities of the parents, together with the connected sexual system in vegetables, and instinctive limitation to its own kind in animals, a considerable uniformity of figure, colour, and character, is induced, constituting species; the breed gradually acquiring the very best possible adaptation of these to its condition which it is susceptible of, and when alteration of circumstance occurs, thus changing in character to suit these as far as its nature is susceptible of change.

(ii) *The Exclusion of Lamarckism*

This circumstance-adaptive law, operating upon the slight but continued natural disposition to sport in the progeny (seedling variety), does not preclude the supposed influence which volition or sensation may have over the configuration of the body. To examine into the disposition to sport in the progeny, even when there is only one parent, as in many vegetables, and to investigate how much variation is modified by the mind or nervous sensation of the parents, or of the living thing itself during its progress to maturity; how far it depends upon external circumstance, and how far on the will, irritability and muscular exertion, is open to examination and experiment. In the first place, we ought to investigate its dependency upon the preceding links of the particular chain of life, varieties being often merely types or approximations of former parentage; thence the variation of the family, as well as of the individual, must be embraced by our experiments.

On Naval Timber and Arboriculture, pp. 384-6

5. CHARLES NAUDIN: 1852

[Nature in forming her species has not proceeded in any other way than we ourselves in creating our varieties: or rather it is her procedure that we have carried over into our practice.] If we wish to extract from any animal or plant species a variety which will meet our requirements, we select (*choisissons*) from amongst the great number of individuals of this species as the foundation of a new stock those which already differ from the type in the direction we want. By a systematic and persistent selection (*triage raisonné et suivi*) of the products for an indefinite number of generations we succeed in creating artificial varieties of species which answer in type more or less to the idea we had formed. And they transmit their new characters (*caractères acquis*) to their descendants in proportion to the trouble we have taken in selecting them over the generations.

Such is, in our opinion, the course of nature. Like us she has wished to form races fitted to her needs. With relatively few primordial types she has brought into being successively at different epochs all the plant and animal species which inhabit the earth. Note, however, that apart from her unlimited power, nature has worked under altogether more favourable conditions than we find today.

In order to subdivide them into secondary types she has taken the primitive types in a nascent state when they retained all their plasticity and when the force of atavism had little effect. But we have to struggle against this inborn inertia (*force invétérée*) reinforced by the prodigious number of generations which have followed the origin of the actual species.

[Nature has worked on an immense scale and with immense resources. We, on the contrary, act with the most limited means. But between her procedures and ours, between her results and ours, the difference is entirely one of quantity. Between her species and those we create there is only the difference between the greater and the less.]

This doctrine of relationship by descent (*consanguinité*) of organic

beings of one family, one class, or even one kingdom is not a new one. Gifted men, equally in France and in other countries, amongst them our learned Lamarck, have maintained it with all their authority. We do not deny that they have in certain respects argued on hypotheses which were not well enough supported by observation. Or that they have used forced interpretations or been led into exaggerations which have most of all contributed to the rejection of their ideas. But these faults of detail do not at all detract from the grandeur or the perfect rationality of the system as a whole. For it is a system which alone accounts for the unity of origin, for the unity of organization, of living beings of the same kingdom, this common basis of our classification of *species* in *genera*, *families*, *classes* and *divisions*.

The opposed system which is in fashion today imagines as many partial and special creations as there are species which we recognize or think we recognize. On this view, to be logical, we have to admit that resemblances between species are purely accidental, an effect without a cause, a conclusion that reason cannot accept. Our system on the contrary makes these resemblances at the same time the *consequence* and the *proof* of a relationship, no longer, metaphorical, but real, with a common ancestor from whom they are derived at more or less remote periods through more or less numerous intermediates ...

On this Darwin writes to Hooker (*Life and Letters*, December 23rd, 1859)

'I cannot find one word like the Struggle for Existence and Natural Selection.'

And in his Historical sketch: 'But he does not show how selection acts under nature.'

III. DESCARTES ON THE IDEA OF EVOLUTION

Far though I am from wishing that everything I write should be believed, I am going to suggest here some things that I consider to be utterly untrue. Thus I do not doubt that the world was created at the beginning with the same perfection it now has; that the sun, the moon and the stars were there from that time; that not only did the earth harbour the seeds of plants but the plants themselves covered a part of it; that Adam and Eve were not created as infants but already of a mature age.

The Christian religion requires that we believe it so and natural reason persuades us entirely of this truth; for if we consider the whole power of God we have to assume that everything he has done has been perfect from the beginning. One would, nevertheless, know much better what nature Adam and the trees of Paradise had if one had examined how the child is formed in the belly of the mother and how plants grow from their seeds rather than if one had only considered them as they were when God created them.

Thus we shall make the nature of everything there is in the world better understood than by just describing it as it is, or rather as we believe it to have been created, if we can imagine certain principles which are quite intelligible and quite simple. According to such principles we should be able to see that the stars and the earth and in short all this visible world could have been produced as though from a few seeds (although we know that it was not produced in this way). And since I think I have found such principles I shall now try to explain them.

Principiarum Philosophiae, 3, § 45: 1644

BIBLIOGRAPHY IN CHRONOLOGICAL ORDER

A. PRIMARY REFERENCES

- DESCARTES, RENÉ, 1644. *Principiarum Philosophiae*. Amsterdam.
- TYSON, EDWARD, 1699. *Orang-Outang, sive Homo Sylvestris*, or the Anatomy of a Pygmie compared with that of a Monkey, an Ape and a Man. (2nd ed., 1751), Roy. Soc. London.
- MAUPERTUIS, P. L. M. DE, 1746 (also 1752, 1768). *Vénus Physique*, contenant deux dissertations, l'une sur l'origine des Hommes et des Animaux: et l'autre sur l'origine des Noirs. La Haye.
- FRANKLIN, BENJAMIN, 1755. *Observations concerning the Increase of Man's kind and the Peopling of Countries*. Boston (cit. Zirkle, 1941).
- MONBODDO, JAMES BURNETT, LORD, 1773-1792. *On the Origin and Progress of Language*. 6 vols. London.
- SPRENGEL, C. K., 1793. *Das Entdeckte Geheimniss der Natur*. Berlin.
- DARWIN, ERASMUS, 1789. *The Loves of the Plants*. London.
- 1794. *Zoonomia or the Laws of Organic Life*. London (French, German, Russian and Italian trans., also New York, 1796).
- 1800. *Phytologia*. London.
- 1803. *The Temple of Nature; or the Origin of Society*: a poem with philosophical notes. London.
- LAMARCK, J. B. DE, 1809. *Philosophie Zoologique*. Paris.
- PRICHARD, J. C., M.D., F.R.S., 1813. *Researches into the Physical History of Mankind* (2nd ed., 1826; 3rd ed., 5 vols. 1836-47) dedicated to Blumenbach; London.
- 1843. *The Natural History of Man*. Comprising inquiries into the modifying influences of physical and moral agencies on the different tribes of the human family. Baillière, London. (4th ed., 1851, cited by Darwin 1871.)
- WELLS, WILLIAM CHARLES, M.D., F.R.S., 1818. Two Essays ... with some observations on the causes of the differences of colour and form between the white and negro races of men. (Papers to Roy. Soc. in 1813.) Constable, Edinburgh.
- ANON. (LAWRENCE, W., F.R.S.), 1819. Article on Man: *Abraham Rees' Cyclopaedia*, vol. 22. Longman, London.

- LYELL, CHARLES, 1830. *Principles of Geology*. Murray, London. (11th ed., 1872.)
- 1863. *The Geological evidence of the Antiquity of Man* (3 editions). London.
- MATHEW, PATRICK, 1831. *On Naval Timber and Arboriculture, etc.* Longman, London. (Appendix 3, repub. *Gardener's Chron.* April 7th, 1860.)
- BLYTH, EDWARD, 1835. An attempt to classify the 'varieties' of animals, etc. *Mag. Nat. Hist.* (London), 8, 40-53.
- 1837. On the psychological distinctions between man and all other animals, etc. *Mag. Nat. Hist.* (London), n.s. 1, 1-9, 77-85, 131-41.
- ANON. (CHAMBERS, ROBERT), 1844. *Vestiges of the Natural History of Creation*. Churchill, London. (10th ed., 1853.)
- NAUDIN, CHARLES, 1852. Considérations philosophiques sur l'espèce et la variété. *Rev. Hort.*, ser. 4: 1, 102-9.
- 1865. Nouvelles recherches sur l'hybridité dans les Végétaux. (Mémoire présenté à l'Académie des Sciences, décembre 1861.) *Nouv. Arch. Mus. d'Hist. Nat.*, 1, 25-174.
- SPENCER, HERBERT, 1852. The Development Hypothesis. *The Leader*, March 20th. (Reprinted in: *Essays: Scientific, Political and Speculative*. Longman, London, 1858.)
- WALLACE, A. R., 1855. On the law which has regulated the introduction of new species. *Annals & Mag. Nat. Hist.*, 16, 184-96.
- 1889. *Darwinism: an exposition of the theory of natural selection with some of its applications*. Macmillan, London.
- 1905. *My Life*. Chapman & Hall, London.
- DARWIN, CHARLES, and WALLACE, A. R., 1858. On the Tendency of Species to form varieties, etc. *Jour. Linn. Soc.*, 3, 45-62 (20. viii. 58) (reprinted 1908, 1958).
- DARWIN, CHARLES, 1859. *On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. Murray, London (24. xi. 59). 1st edition reprinted 1950, Watts, London. 3rd to 6th edition with *Historical Sketch*: 1861, 1866, 1869, 1872.
- 1868. *The Variation of Plants and Animals under Domestication* (including the Provisional Hypothesis of Pangenesis). J. Murray, London.

- 1871. *The Descent of Man and Selection in Relation to Sex*. J. Murray, London.
- 1876. *The Effects of Cross and Self Fertilization in the Vegetable Kingdom*. J. Murray, London.
- 1879. *The Life of Erasmus Darwin*. Being an introduction to an Essay on his Scientific Works by Ernst Krause. (Trans.) J. Murray, London.
- MENDEL, G., 1865. Versuche über Pflanzenhybriden. *Verh. naturf. Ver. Brünn*. 4. Trans. in: (i) W. Bateson, 1909. *Mendel's Principles of Heredity*. C.U.P., Cambridge; (ii) *Experiments in Plant Hybridization*. Harvard, 1956.
- ANON. (JENKIN, H. C. FLEEMING), 1867. The Origin of Species. *N. Brit. Rev.*, 46, 277-318: reprinted in *Papers*, ed. S. Colvin and J. A. Ewing. London, 1887.
- HAECKEL, ERNST, 1868. *Natürliche Schöpfungsgeschichte*. (Engl. trans.: *History of Creation*. London, 1876.)
- GALTON, FRANCIS, 1869. *Hereditary Genius*. Macmillan, London.
- 1883. *Inquiries into Human Faculty and its Development*. Macmillan, London.
- BUTLER, SAMUEL, 1877. *Life and Habit*. London.
- 1879. *Evolution, Old and New: or the Theories of Buffon, Dr Erasmus Darwin and Lamarck as compared with that of Charles Darwin*. London.
- 1880. *Unconscious Memory*. London.
- 1885. *Luck or Cunning*. London.
- 1890. *Essays (Deadlock in Darwinism)*. London.
- HUXLEY, T. H., 1878. *Evolution in Biology*. (A retort to Butler.) Reprinted 1893 in 'Darwiniana' with note added admitting injustice to Erasmus Darwin. Macmillan, London.
- 1863. *Evidence on Man's Place in Nature*. Reprinted 1893.
- 1887. On Reception of the Origin of Species. (*Life and Letters of Charles Darwin*, vol. 2, ch. 5.)
- DARWIN, FRANCIS, 1887. *Life and Letters of Charles Darwin*. J. Murray, London.
- 1903. *More Letters of Charles Darwin*. J. Murray, London.
- 1909. *Early Sketches of the Origin of Species (1842, 1844)*. Cambridge, 1909.

WEISMANN, A., 1889. *Essays upon Heredity*, etc., trans. E. B. Poulton et al. Oxford.

- II. *On Heredity* (1883).
- III. *The Continuity of the Germ-Plasm as the Foundation of a Theory of Heredity* (1885).
- V. *The Significance of Sexual Reproduction in the Theory of Natural Selection* (1886).
- VI. *On the Number of Polar Bodies and their Significance in Heredity*.
- VII. *On the Supposed Botanical Proofs of the Transmission of Acquired Characters* (1888).
- VIII. *The Supposed Transmission of Mutilation* (1888).

B. SECONDARY REFERENCES

- OSBORN, H. F., 1894. *From the Greeks to Darwin*. Macmillan, N.Y.
- POULTON, E. B., 1897. A Remarkable Anticipation of Modern Views on Evolution. *Sci. Progress* (N.S.) 1, 278-95.
- 1905. T. H. Huxley and the Theory of Natural Selection. In: *Essays on Evolution: 1889-1907*. Oxford, 1908.
- CUNNINGHAM, D. J., 1908. Anthropology in the Eighteenth Century. *J. R. Anth. Inst.*, 38, 10-35.
- BATESON, W., 1909. Heredity and Variation in Modern Lights. *Darwin and Modern Science*. Ed. A. C. Seward. C.U.P., Cambridge.
- JUDD, J. W., 1910. *The Coming of Evolution* (The Geological View). C.U.P., Cambridge.
- HADDON, A. C., 1910. *History of Anthropology* (with bibliography: based on Cunningham). Watts, London.
- MARCHANT, J., 1916. *Alfred Russel Wallace: Letters and Reminiscences*. Cassell, London.
- ROBERTS, H. E., 1929. *Plant Hybridization before Mendel*. Princeton, U.P.
- FISHER, R. A., 1929. *The Genetical Theory of Natural Selection*. Oxford.
- PEARSON, HESKETH, 1930. *Doctor (Erasmus) Darwin*. London.
- WEST, GEOFFREY, 1937. *Charles Darwin, the Fragmentary Man*. Routledge, London.

- ASHLEY MONTAGU, M. F., 1943. Edward Tyson, M.D., F.R.S., 1650-1708, and the rise of human and comparative anatomy in England. *Mem. Am. Phil. Soc.*, 20. Philadelphia.
- LYSENKO, T. D., 1943. *Heredity and its Variability*. (Trans. Th. Dobzhansky.) King's Crown Press, New York.
- ZIRKLE, CONWAY, 1941. Natural Selection before the 'Origin of Species'. *Proc. Amer. Phil. Soc.*, **84**, 71-123.
- 1946. The early history of the idea of the inheritance of acquired characters and of pangenesis. *Trans. Am. Phil. Soc.*, **35** (2), 91-151.
- GLASS, BENTLEY, 1947. Maupertuis and the beginning of Genetics. *Q. Rev. Biol.*, **22**, 196-210.
- DARLINGTON, C. D., 1947. The Genetic Component of Language. *Heredity*, **1**, 269-86.
- 1952. Purpose and Particles in the Study of Heredity. *Science, Medicine & History. Oxford*, **2**, 473-82.
- 1953. *The Facts of Life* (ch. 5: The Coming of Genetics). Allen & Unwin, London.
- 1958a. *Evolution of Genetic Systems*. 2nd ed. Oliver & Boyd. Edinburgh.
- 1958b. The Control of Evolution in Man. *Nature*, **182**, 14-17.
- BUSH, DOUGLAS, 1950. *Science and English Poetry: 1590-1950*. Oxford.
- KEITH, SIR ARTHUR, 1955. *Darwin Revalued*. Watts, London. (Cf. C. D. Darlington, *Eug. Rev.*, **47**, 4.)
- CROMBIE, A. C., 1957. P. L. Moreau de Maupertuis, F.R.S. (1698-1759) Precurseur du Transformisme. *Rev. de Synthèse*, **3**, 36-56.
- BARLOW, NORA, 1958. *The Autobiography of Charles Darwin. 1809-1882*. With original omissions restored, edited with Appendix and Notes. Collins, London.
- HUXLEY, J. S., 1958. The Emergence of Darwinism. *J. Lin. Soc. Zool.*, **44**, (295).
- EISELEY, LOREN, 1958. *Darwin's Century*. Gollancz, London.
- 1959. Charles Darwin, Edward Blyth, and the Theory of Natural Selection. *Proc. Amer. Phil. Soc.*, **103**, 94-158.

C. THE LAWRENCE CONTROVERSY

From *British Museum Catalogue of Printed Books* (by Mr Paul Harvey of the Department of Manuscripts).

LAWRENCE, W., F.R.S., *Lectures on physiology, zoology and the natural history of man*. London. (Dedicated to Blumenbach.)

- (1) 1819¹ (J. Callow) 579 pp.
- (2) 1822² (W. Benbow) 500 pp.
- (3) 1822 (Kaygill & Price, no plates) 2 vols. — 288 pp., 212 pp.
- (4) 1823^{1,3} (J. & C. Smith, new plates) 532 pp.
- (5) 1844 (J. Taylor, old plates) 'ninth edition — stereotyped' 396 pp.
- (6) 1848⁴ (H. G. Bohn) 'ninth edition', as (5).

Other items in the British Museum catalogue of printed books under the heading of W. Lawrence, *Lectures on physiology* ...

(i) REPRINTED EXTRACT

Facts versus Fiction! An essay on the function of the brain. London, Watson, 33 Windmill St., Finsbury, 1832.

Four pages of 'Preliminary remarks', unsigned, of an anti-clerical bias, concluding with an eulogium of Lawrence — 'who, in pursuing the paths of science, levelled in his march the rotten fabrics of superstition, and scorned to contaminate the professor's gown by prostituting his genius to ignorance and fanaticism. The name of Lawrence shall be transmitted to posterity with respect and veneration, while those of his enemies are but glanced at and forgotten'.

—— 2nd edn. London, 1840. 784 e. 20.

¹ Copies in Bodleian Library: texts identical in the two editions. 1819 is the authentic edition marked 'suppressed' in the Bodleian catalogue.

² Cited by Darwin (1871) in five footnotes on points of detail (as with Prichard).

³ Cited by Bateson (1909) in a footnote on the principle of the inheritance of acquired characters.

⁴ Referred to in A. R. Wallace's *My Life* as 'a new cheap edition'.

(ii) CONTROVERSIAL WORKS

Anon. (probably William Grinfield, M.A. Oxon.), 1819. *Cursory observations upon the Lectures ... by W. L.* ... By one of the people called Christians. 728 d. 25; B. 488 (14).

Rennell, T. (B.D., F.R.S., etc.), 1819. *Remarks on scepticism ... Being an answer to the views of ... Mr Lawrence* ... 4015 e. 32.

'Oxonian', 1820. *The Radical Triumvirate*; or Infidel Paine, Lord Byron and Surgeon Lawrence, colleaguings with the Patriotic Radicals to emancipate mankind from all laws, human and divine, 8135 ccc. 30 (5).

'*Philostratus*', 1823. *Somatopsychonologia* ... Being an examination of the controversy concerning life carried on by M. M. Lawrence, Abernethy ... 528 i. 28.

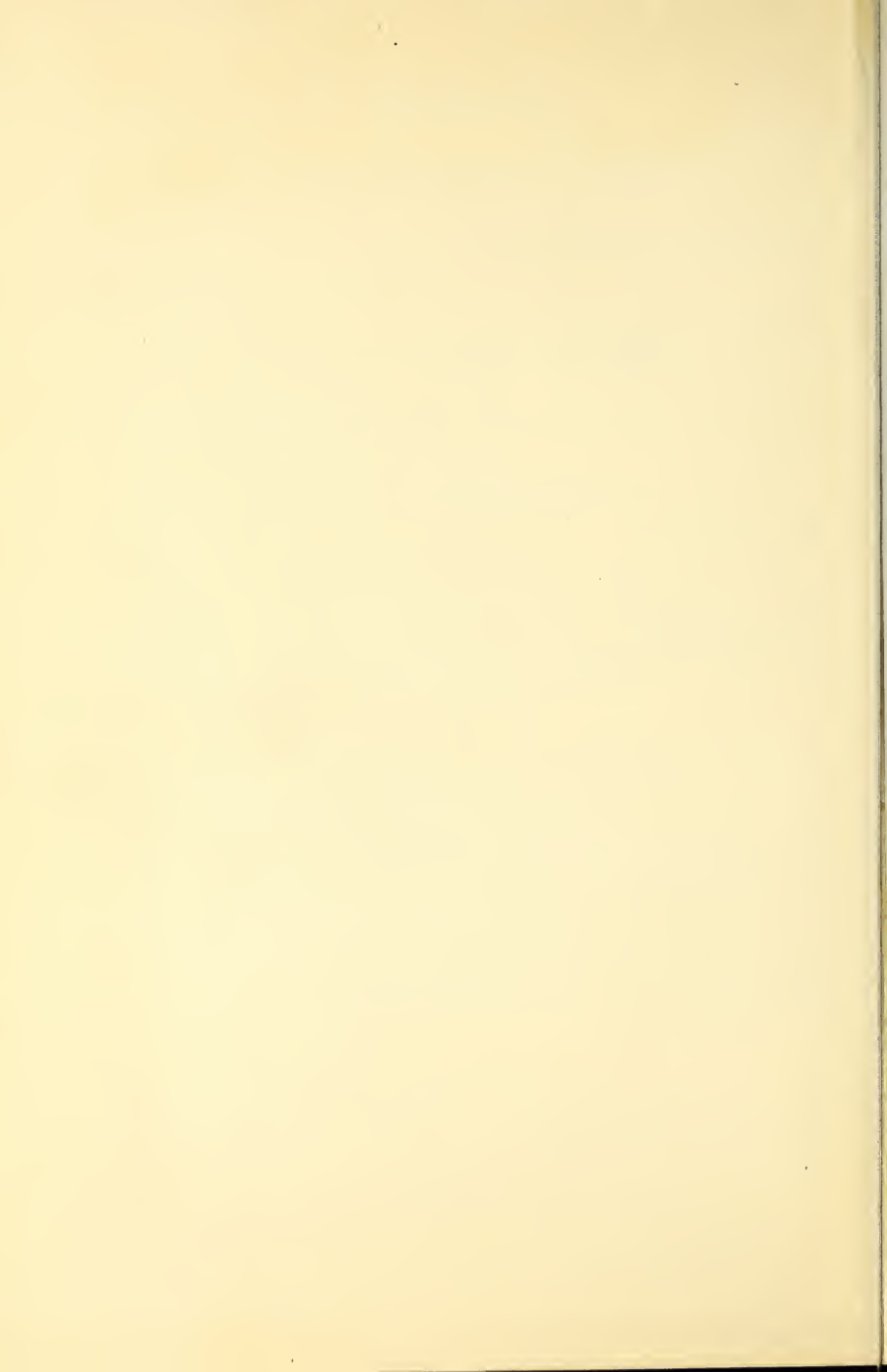
Anon., 1824. *An essay upon the relation of cause and effect ... with observations upon the opinions of ... Mr Lawrence*, connected with that same subject. 528 k. 20.

Anon., 1827. *Thought, not the function of the brain*: a reply to the arguments for materialism advanced by W. Lawrence, in his lectures on physiology. 7410 bb. 6.

Amringe, W. F. van, 1848. *An investigation of the theories of the natural history of man by Lawrence* ... 10007 i. 4.

NOTE by Mr Harvey.

One of Lawrence's letters in the Department of MSS relates to the *Lectures*. It is addressed to William Hone (bookseller, d. 1842), undated, but on paper watermarked '1820' — '... I beg you to accept the accompanying copy of my lectures, and to assure you that although I thought it expedient to withdraw this work from circulation, no considerations of expediency would ever induce me to shun the appearance of intimacy with one whom I respect so highly for talent and the most important public services as well as for the possession of much greater courage in these matters than falls to the lot of Yours very faithfully, W. Lawrence'. (Add. MS. 40120, f. 171.)





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